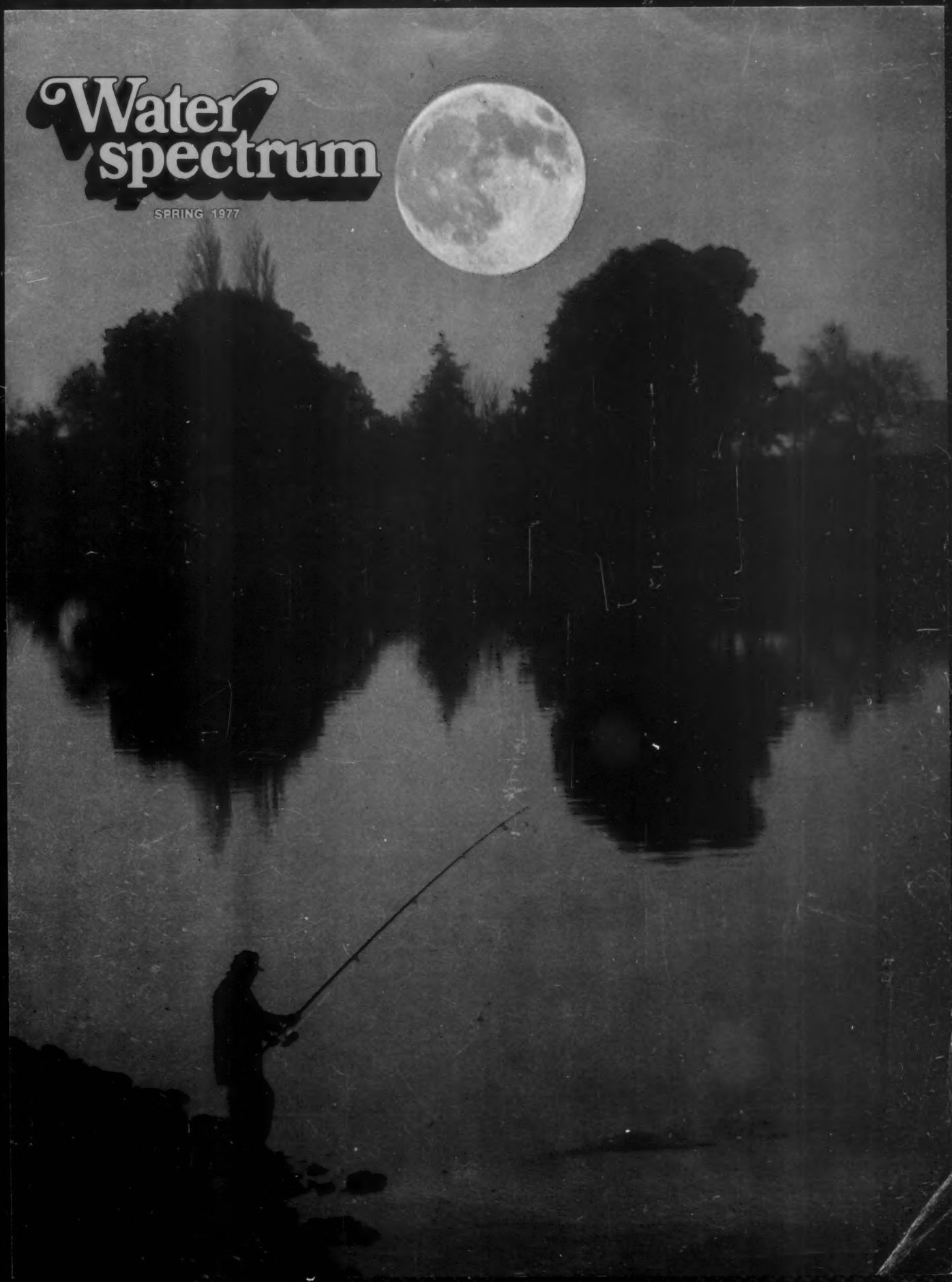
Water spectrum

SPRING 1977



Water spectrum

Published Quarterly Vol. 9, No. 2, Spring 1977

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America's Regulatory Age Arrives 1
by Tom Barlow

Competing for Survival 7
by Marc J. Imlay

Britain Pursues A National Water Policy 15
by D. L. Perridge

Update: Overland Flow 23
by P. G. Hunt, C. R. Lee and R. E. Peters

Ice on the Ohio 30
by Martin Pedigo

Flood Insurance 37
A Growth Story
by J. Robert Hunter

Events, Deeds & Deliberations 44

Comments on topics in this publication are invited. Send to:
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Washington, D.C. 20314

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Use of funds for printing this quarterly publication was approved by the Director of the Office of Management and Budget through June 30, 1977.

A major purpose of this publication is to serve as a written forum for the open discussion of issues and choices in resolving water resource problems. Views and conclusions expressed or implied do not necessarily reflect the position of the Corps of Engineers.

Subscription rate is $6.20 per year; $1.55 additional for foreign mailing. Price of a single copy is $1.55. Order directly from Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

This issue developed by Office of Staffing and Management, Directorate of Civil Works.

Address changes: Please attach old address label to request for changes.

COVER: Proper and fair regulation can preserve the pleasures of sport fishing while meeting the growing demands for multiple uses of our finite water resources. See page 1

Tracy I. Borland

America's Regulatory Age Arrives

Besides storing and carrying overbank flows, wetlands provide important waterfowl habitat.

by Tom Barlow

The author is a member of the staff for the Natural Resources Defense Council, an environmentally oriented non-profit organization that has had in-depth experience dealing with the regulatory functions exercised by many Federal agencies.

The history of America's development has been a chronicle of the increasing use of America's watercourses and the adjacent land area. The rivers quickly became and continue to increase in importance as major arteries of commerce. The grid of rails and roads later woven across the Nation often hugged hard against stream and river banks because they afforded ease of topographical access.

Rich agricultural empires spread along the fertile bottom lands of the flood plain. Power from flowing waters encouraged the early location of mills and factories alongside the swifter streams and rivers. The advance of technology later brought hydroelectric dams. Watercourses also carried away wastes very purposely piped into the stream flow and refuse heedlessly dumped over the banks. These watercourses that car-

Controlling point sources of pollution is only half the battle to keep the Nation's water clean.

Public health considerations demand that public water be kept free of pollution.

ried away our wastes, however, could not continue to be the same sources we would draw upon for human and animal consumption and domestic and industrial uses. Furthermore, filthy water is a destroyer of the rich recreation resource that both flowing and flat waters provide—a resource that furnishes a unique and powerful experience in American life.

Intent upon our own complex and often competing uses, we tend to forget that nature has her own, very necessary use for these same watercourses—the carrying off of excess surface and groundwater. Since we do not control the weather—neither the snows of winter nor the rains of spring—periodically large amounts of water must be drained away.

Vital to the proper functioning of the hydrologic cycle are the areas adjacent to these streams and rivers, the flood plains that help to store and carry overbank flows of high water. Such areas should be considered integral to a watercourse and to the Nation's system of inland and coastal watercourses. As major portions of these flood plain areas are filled in for development or bottom lands are separated from their channels by levees built to protect agriculture and nearby communities, the channel capacities of these watercourses become progressively constricted.

The impacts can be felt upstream as high water flows, denied easy access to lower basin areas, back up and spread onto land never before flooded; and the impacts can be felt downstream as high rates of flow moving through a constricted channel scour soil from its bed and banks and transport that same soil downstream to form channel-blocking deposits. Thus, man's activities throughout a river basin profoundly influence the manner in which nature exercises her own watercourse needs, needs which must be met or resources are impaired and, on occasion, natural disasters compounded.

The quality of water in our streams and rivers also is affected by the manner in which adjacent land is used. Alteration of natural conditions in watersheds and basin areas of a river affect channel volumes and rates of flow. One of the reasons America's system of national forests was established in the latter part of the 19th century, and later expanded in the 1930s, was to maintain a permanent forest cover in headwater areas to retard flood-generating levels of runoff from annual snowmelts and prolonged heavy rains.

Failure to pursue proper soil conservation practices on agricultural lands causes the erosion of more than 2 billion tons of precious topsoil into the Nation's streams and rivers every year. Despite 40 years of attention by the Federal government, this problem is getting worse. These sediments clog the streams and

Unregulated upstream flood plain development could conceivably increase downstream flood volumes sufficiently to overtop this typical floodwall at Tell City, Indiana.

foul the waters necessitating expensive dredging and water treatment by downstream users. About half the pollution of the streams and rivers flowing into the Great Lakes, for instance, comes from such *nonpoint* sources as erosion. So, in a very real sense, our national effort to cleanse the Nation's waters, which has concentrated on controlling *point* sources, is addressing only half the battle.[1]

Historically, State and Federal law was characterized by policy directives being given to the Federal agencies responsible for different facets of the Nation's water resources with lawmakers directing the Federal agencies to provide for all uses. However, problems develop with this broad brush legislative approach. Free-for-all battles over priority are encouraged between uses, with the strongest user usually prevailing. And yet uses thus frustrated may be valid or provide public values. Fierce struggles ensue and many such battles spill into the courts. Legal refinements were needed to protect the interests of all users.

In the River and Harbor Act of 1899 Congress gave the Corps of Engineers responsibility for making certain, through a regulatory process, that the dumping of refuse in a watercourse, at that time a commonly accepted practice, did not interfere with commercial navigation. Since an infinite variety of materials could be involved in such dumpings and they could or could not be a hazard to navigation depending upon channel configurations and the behavior of the currents, the decision to allow or disallow the dumping is best made by the experts in navigation and watercourse conditions on a site by site basis.

When Congress decided, in the 1960s, that the public health and the economic well being of the Nation demanded that the flushing of polluted waters into streams and rivers be checked, it gave the Environmental Protection Agency the regulatory responsibility to make sure that citizens downstream were not going to be sickened or slowly poisoned by the flushing of sewage and industrial wastes upstream. Again Congress preferred to have the permit decisions made by experts in water quality and the assimilation capacities of water bodies rather than by a committee of lawmakers. Were such a committee to exist, it would probably have to be travelling constantly and meeting in continuous session to process all the permit applications.

With the regulatory approach, an agency applies to a specific situation the broad outlines and goals fashioned by Congress. This is a tailoring function by experts who are trying to meet the complex and always unique mixes of local needs while, at the same time, fulfilling broader regional and national criteria.

Rather than halting planning, the regulatory approach seeks to assure the optimum mix of uses where demands

[1] *Nonpoint* sources refer to those ill defined regions along a bank where runoff carries eroded soil and other pollutants into the stream flow, whereas *point* sources of pollution can be identified as specific outfall pipes or other points of entry into the water.

Issuance of permits for partial development of a community on Marco Island provides area with economic benefits while preserving western Florida's ecologically valuable coastal mangrove swamps.

are in conflict. For instance, there is no intent to halt future development of wetlands in the Corps of Engineers permit program to regulate the disposal of dredged material or fill under section 404 of the 1972 amendments to the Federal Water Pollution Control Act. However, the 404 program at least assures us of careful and expert review of each planning effort and that a balance will be struck between the desires of developers and the local, regional and national needs for protection of these wetlands which provide for other important social values and public uses. Furthermore, where a proposed drainage and development of wetlands is approved, its permit can stipulate the use of methods that will not significantly damage the natural resources associated with those wetlands.

After a very thorough analysis, and public review procedures that involved all parties, the Corps made an excellent regulatory decision in issuing 404 permits for partial development of Marco Island. As a result of these proceedings, jobs will be provided in areas to be developed; and certain valuable Florida coastal mangrove swamps, on which important offshore fishery ecosystems are dependent, will continue to provide for rich marine harvests.

What are the values of the regulatory approach in resolving public concerns? If the regulatory function is properly exercised, Federal agencies can shoulder an important share of the many, increasingly complex, resource utilization issues being thrust at Congress for resolution by the public every year. The agencies can provide the forums in which every side has an opportunity to make its case. Of course, if bias seems to prevail in the final decision or regulatory procedures have been improperly handled, appeals can be made to the lawmakers, but then the lawmakers have a full and complete record of agency procedures and the expertise of witnesses to which they can direct oversight and on which they can base their judgments.

Another value of the regulatory approach is its flexibility to accommodate changing conditions or demands and to assure the timely application of evolving technology. Rather than foreclosing an action outright, a permit might be issued based on one set of circumstances and then as conditions change the permit can be reissued under new guidelines, all the while assuring that public values are protected.

Regulatory procedures also provide a useful safety valve for aroused public sentiment. The adjustments made in ongoing activities as a result of regulatory processing can provide a constructive working-out

Offshore fishery ecosystem depends on maintenance of coastal wetlands as breeding areas for marine life.

process for developing problems without which precipitate and perhaps unwise action might be demanded. An example: In certain areas of the Far West, cattle are beginning to show concentrations of chemical residues from herbicides in their meat tissues, herbicides being applied in forestry and brush control programs. If, at some future point, such concentrations are found to endanger public health and meat sales must be restricted, wouldn't it be wise to have the regulatory reach to restrict the herbicide culprit? Such early regulatory restriction could confine herbicide application to areas of critical need, thereby solving specific vegetative problems while avoiding the health problems that would be caused by permitting general broadcast applications of that herbicide. Without this regulatory tailoring to avoid problems, the public clamor over the problems might result in a complete ban which would of course foreclose any benefits from the activity.

Application of the regulatory process can be simple or complex depending on the site and use mix being regulated. From an operational standpoint, dangerous or nuisance uses are perhaps the easiest to isolate and regulate. A use which so seriously damages the common resource that other uses are curtailed or halted, and

Public hearings provide a forum for all sides to make their cases.

Upland alterations of drainage patterns, unless properly regulated, many compound future downstream flooding.

which therefore should not be tolerated, is relatively simple to interdict.

Determining the threshold beyond which that use becomes intolerable is more complex. For instance, to what point should we allow one use to undermine competing uses? A good example is that of upstream wetland areas. Such areas provide a natural flood control function by temporarily storing excess stream flows. To what extent should the filling in of these wetlands be allowed, bearing in mind that as a result downstream flooding may increase. These wetland areas also provide a cleansing function by filtering out waterborne pollutants and sediments. Filling of these wetlands may thus cause the delivery of progressively dirtier water downstream. This, in turn, would require higher tax expenditures by downstream users for the removal of pollutants heretofore captured by the upstream wetlands—assuming that a manmade municipal filtration system is capable of matching nature's cleansing function.

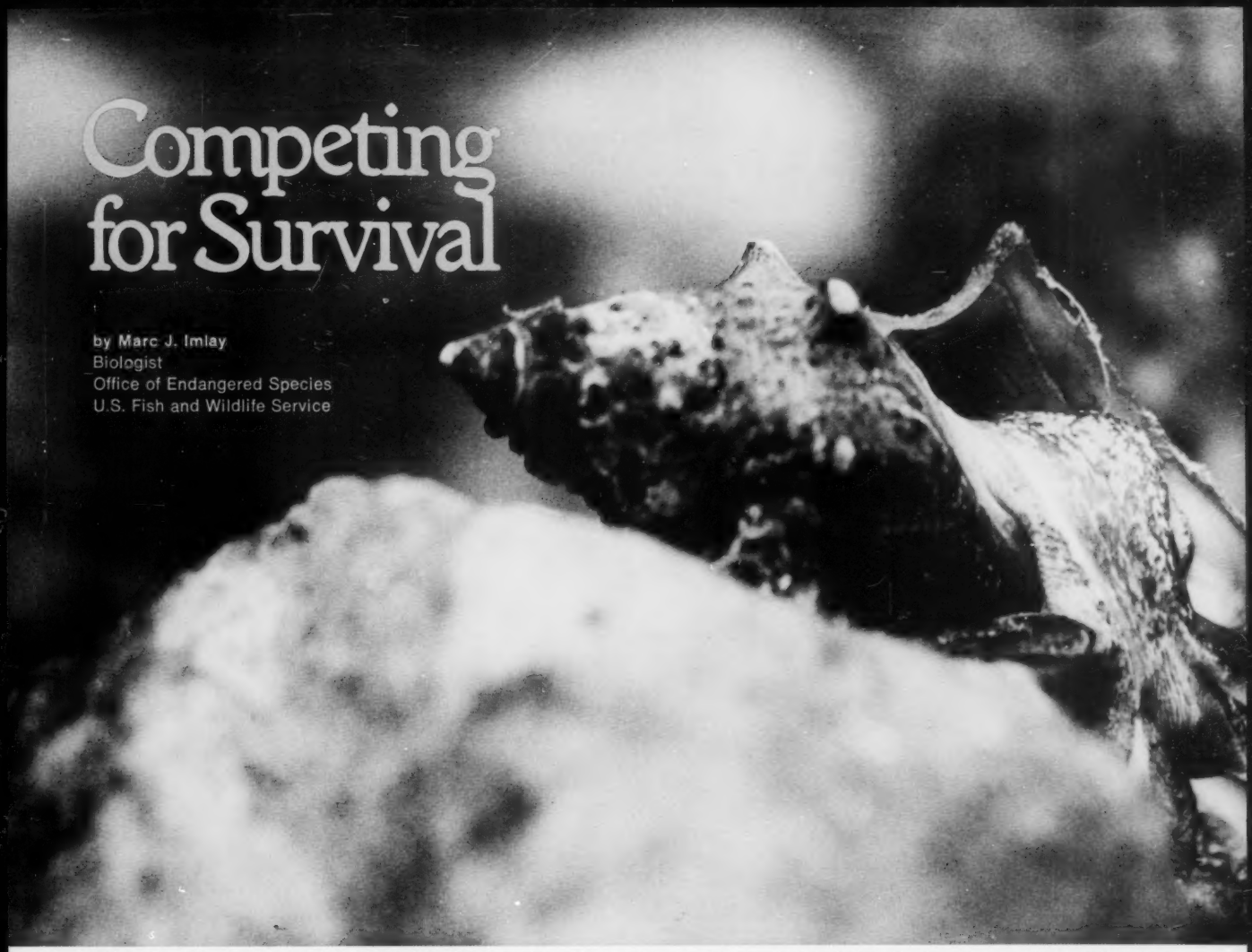
While Federal agencies are coordinating their own development programs, much private work still goes on that can have consequences which conflict with public projects. The regulatory process provides the opportunity to coordinate such private and public efforts to resolve conflicts. There is evidence that public and private levee work in the lower Mississippi basin can be better coordinated for the public's benefit.

Private development work in wetlands can have unfortunate consequences if not properly engineered. For instance, logging roads cut through swamps can block upland drainage and back up water onto farmlands and forests, killing both crops and trees. The solution does not have to be the prohibition of such roads, but only to make sure that when built, they are properly culverted to accommodate necessary drainage. An expert exercising regulatory surveillance of these activities can make certain that the appropriate work is done.

Why do we need regulation with a national scope? When the use of a resource, such as water, has national implications which could impact on other uses beyond a State or a region, then a national forum must evolve to set the appropriate standards. We must bear in mind that if States or localities were to have the right to grant themselves broad exceptions to the standards, serious inequities could result. □

Competing for Survival

by Marc J. Imlay
Biologist
Office of Endangered Species
U.S. Fish and Wildlife Service



This spiny river snail, lodged in inverted position, is shown here trying to right itself. It is being considered for endangered status.

The clean gravel shoals beneath the swift, cool, clear waters that line a portion of the Little Tennessee River in Loudon County, Tennessee are unique. This 17-mile stretch is the first area in the United States to be officially determined a "critical" habitat, for it is the only known home of a tiny fish called the snail darter. This same locale is slated to be covered by impounded river waters when the Tellico Dam is completed.

The Tennessee Valley Authority, which is building the dam, is being sued by private citizens who want to halt the dam's construction. They claim that impoundment of water behind the structure poses a threat to the existence of the darter. A Federal court has ruled in favor of continuing construction on grounds that a large amount of capital has been invested in the project and the fact that the darter was not discovered until after construction started. The case is under appeal and construction is proceeding. However, the agency is enjoined from filling the dam's reservoir until the legal issues are resolved.

In another recent case, the U.S. Supreme Court pro-

Photos by Hans Stuart, U.S. Fish & Wildlife Service

New River in Virginia is inhabited by 25 species of molluscs, fish and crustaceans which are candidates for listing.

tected the Mississippi sandhill crane by refusing to review an appeals court decision that permanently halted construction of an interstate highway through the birds' habitat.

The Tennessee-Tombigbee Waterway project of the Army Corps of Engineers also has landed in the courtroom. One of the claims in a railroad company's suit is that the project is violating environmental statutes. Among the aquatic residents of the affected Tennessee-Alabama-Mississippi area are five species of molluscs which the U.S. Fish and Wildlife Service believes are endangered by the navigation project.

Unfortunately, there often is no really satisfactory solution to this relatively new type of coexistence problem. Only in recent years has the extinction of species and subspecies been generally recognized as a biologically undesirable occurrence. Not until late in 1973 did the United States enact a strong law to protect endangered creatures and plants in their unequal competition with man for habitat and other resources.

One proposed solution to this coexistence problem is mitigation, which can mean transferring affected species to other, similar locations. But even in those rare cases where mitigation appears to be successful—and so far few of the transplanted darters are surviving—years must pass before biologists can be certain that transplanted species such as molluscs will be able to reproduce at a rate high enough to assure their survival.

Creating new habitat is similarly risky and also expensive. The level of technical expertise necessary for duplicating a watery molluscan habitat has not yet been achieved.

Molluscs—clams, snails, limpets, oysters, mussels, slugs, octopuses and squid—are affected by many human activities. The single most important threat to aquatic endangered species is the erosion of our topsoil with the consequent silting of our streams. Research is needed into land treatment of erosion to replace stream channelization, which is carried out by the Corps of Engineers and other agencies, because dredging and channelization of streams eradicates nearly all bottom life for a decade or more. Even where some bottom life

has returned, no instance is known where the diversity has reached even 50 percent of the original number.[1]

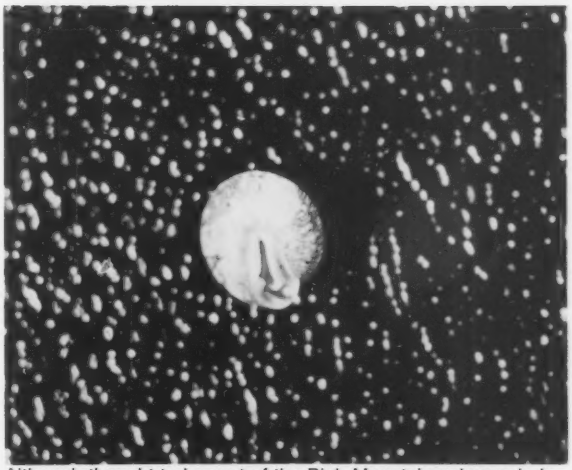
Another big problem that molluscs face is large dams. The principal difficulty with these structures is that they are usually constructed in rural areas likely to contain abundant wildlife. When the land is inundated, a large portion of our dwindling wildlife is destroyed.

A third problem is pollution. Adding waste, treated or untreated, to unpolluted or slightly polluted streams causes a degree of degradation in water quality. On the other hand, using streams which are moderately or heavily polluted for the disposal of well-treated wastes may improve existing water quality. It is necessary to compare the effects of ozone treatment to chlorination of wastes, secondary to tertiary treatment, and compare all of these to land treatment.

In recent years there has been an unfortunate tendency to make enormous efforts to clean up streams that are already dead and, at the same time, to allow the water quality in slightly polluted streams to deteriorate to the point of species extinction. This leveling trend toward homogenization of the water quality and aquatic life in our rivers would be counteracted by carrying out the water pollution control efforts which are necessary to protect these aquatic endangered species.

Finally, the risk of hybridization generally corresponds to increasing disturbance of the habitat by pollution, channelization, dredging, deforestation and other such operations. Land snails, for example, have been found to hybridize, or produce offspring of mixed parentage, in disturbed areas.

[1] *Ed. Note:* The Corps is currently researching dredging and disposal of dredged material at the Environmental Effects Laboratory at its Waterways Experiment Station at Vicksburg, Mississippi.



Although thought to be part of the Rich Mountain salamander's diet, Pilsbry's narrow apertured land snail is extraordinarily modified for keeping out other predators.

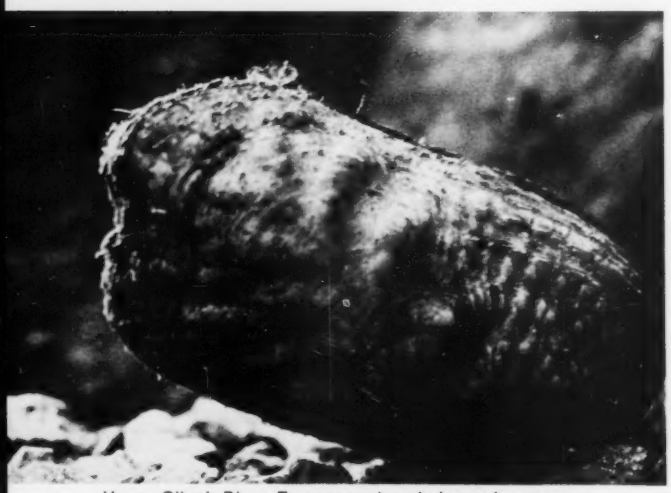
The importance of dam building, dredging, waste treatment or their alternatives (relocation of buildings, railroads or recycling) is easily understood. Many dams are designed to protect lives and property from flooding; dredging aids navigation and transportation, and waste treatment is certainly essential for our good health. Many persons, however, ask why seemingly insignificant molluscs are also important to man.

A diversity of species provides resilience, adaptability and stability to the web of life which covers our planet. Once a species becomes extinct, its genetic composition and all of its potential values as a natural resource are lost to mankind. For instance, molluscs rarely get cancer. One of its substances (mercenene) that has already been isolated prevents or delays two types of cancer in mice and has had no side effect when tested on human amnion cells. When potential values such as this are lost through extinction of a species or subspecies, the thin web of life on earth is forever diminished by just that much.

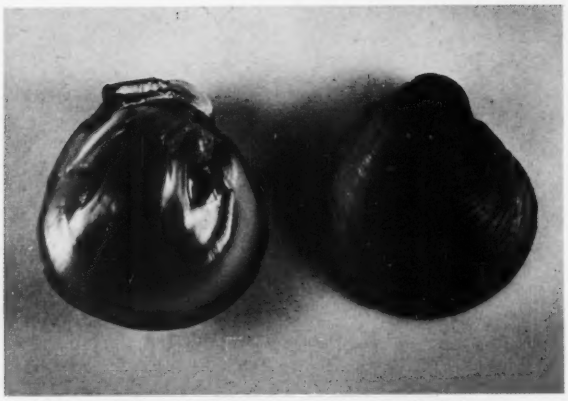
Already snails and mussels are serving man by acting as a gauge of the health of stream ecosystems. They are a valuable link in the food chain because they make up part of the diets of birds, mammals and other aquatic species.

Molluscs constitute the second largest group of animal or plant life in the world. Comprised of some 120,000 species, they are exceeded only by the group containing insects.

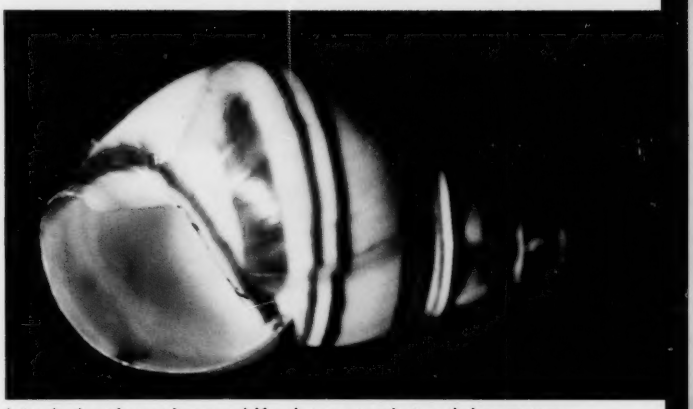
They first appeared during the Paleozoic era of 500 to 600 million years ago. Molluscs are by and large a very successful stage between early stationary animals,



Upper Clinch River, Tennessee is sole home for many species of plants, fish and invertebrates, including this rough rabbit's foot pearly mussel.



Unlisted but believed to be endangered, the golf stick pearly mussel lives in the Green River, near Mammoth Cave National Park in Kentucky.



Introducing the endangered Key Largo woodrat and deermouse to Lignumvitae Key, Florida jeopardized the existence of this local tree snail.

Recent completion of the Normandy Dam on Duck River, Tennessee has rendered the turgid riffle shell mussel effectively extinct. Of the 40 species of riffle shell mussels that once existed in the eastern United States, about half are now extinct.

sponges and coral for example, and more aggressive food seekers such as insects and crustaceans. While they belong to the external skeleton line of arthropods rather than the internal skeleton line of chordata, their great life style represents an alternative to either line because they possess both active and passive parts. Their slow but active animal parts, the foot and head, allow them movement while their passive vegetal[3] part stores food for months or years and protects them from dessication and predation.

Inadvertently, I once left a live-bearing freshwater snail, *Viviparus malleatus,* in a dry finger bowl over an entire summer. Within hours after this sealed shut, presumably dead animal was replaced in water, it was moving about actively.

Furthermore, the watery nature of molluscs' soft tissue makes all sorts of wonderful metabolic and excretory activities possible. For instance, their watery tissue enables them to isolate and store an inordinately high number of compounds, some of them substances which are extremely toxic to man. This capability also gives them a very effective waste metabolism so that some of the energy normally required for excretion is freed for other activities.

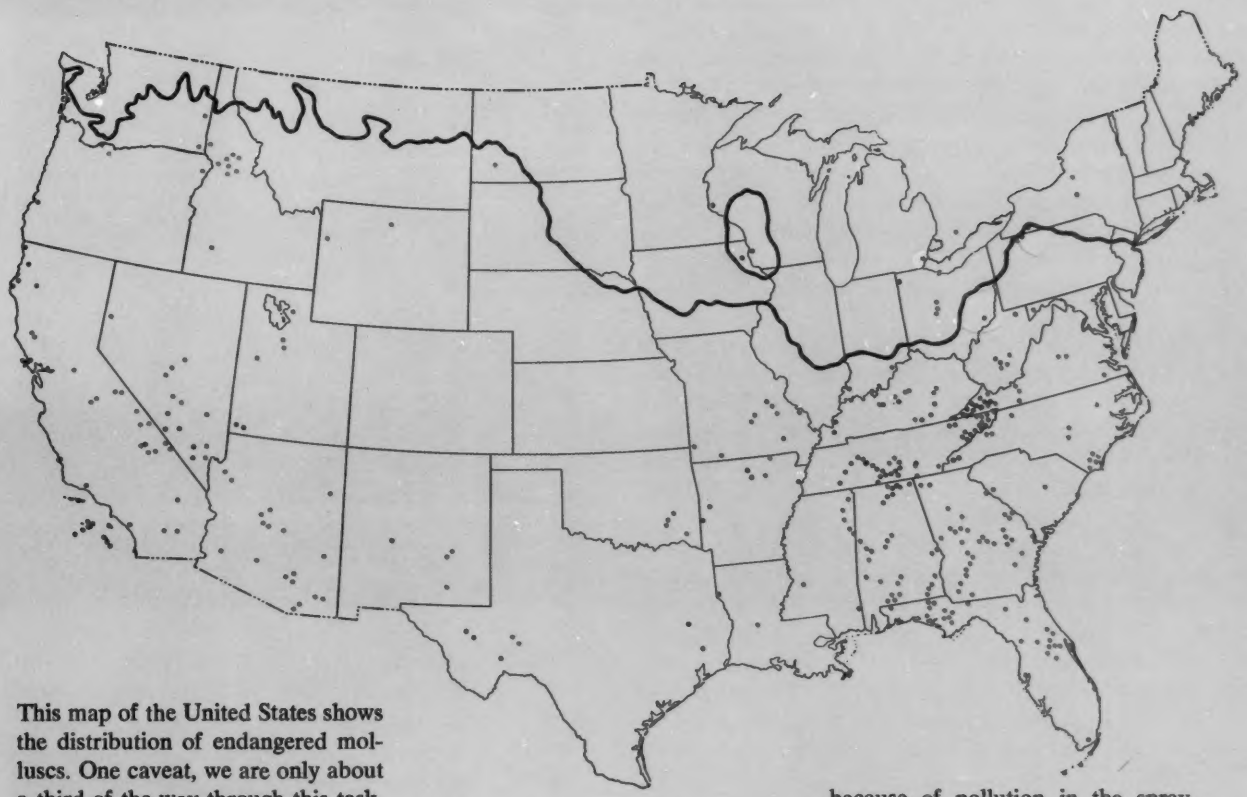
Freshwater mussels daily produce urine equivalent to 24 percent of their body weight, including shell. Their high water content then helps the mussel reabsorb from the excreted urine the sodium, chloride and calcium which so efficiently helps them maintain their osmotic balance.

Historically, the normal rate of molluscan extinction has ranged from 10 to 20 percent every million years. For example, a study of freshwater and land molluscs of the Blancan period of 2 to 5 million years ago shows that 11 of 50 molluscs from a Kansas rock formation, 21 of 31 molluscs from a California formation, and 4 of 20 from a Florida formation have become extinct worldwide.

The natural mean time span of individual snail species is reported to be 5 million years under stable conditions. Generally speaking, the natural extinction rate has been equal to the replacement rate over the long run. In the 50 United States, however, the extinction rate now equals 20 percent in 1,100 years for 56 documented molluscan extinctions have occurred since 1876. Today, this man-caused extinction rate has accelerated and 15 percent of living molluscs are expected to vanish in the next 5 to 15 years. Similar extinction rates have been found among almost all groups studied all over the world: mammals, birds, fish, crustaceans and plants. In short, 15 percent of living diversity is endangered.

Such worldwide mass extinctions have occurred only a few times in the history of the earth. Perhaps 40 per-

[3] Having or showing plantlike life or growth.



This map of the United States shows the distribution of endangered molluscs. One caveat, we are only about a third of the way through this task. In red are officially listed and proposed species. In blue are other endangered or threatened molluscs. The heavy black line denotes the southern extremity of the Wisconsin ice sheets of some 10,000 years ago. Earlier ice ages penetrated even deeper. Virtually all of the endangered molluscs are found south of the heavy black line. Northern species were pushed south or extirpated (wiped out).

Notice the importance of the unglaciated areas of French Creek in New York and Pennsylvania, the Muskingum River in Ohio, and the Kickapoo-Driftless area in Wisconsin (see shaded areas). They are northern refuges for many northern species. The northern tips of Greenland and Central Alaska may also be important for the same reason.

Some of the species that were pushed south later migrated back north, including, perhaps, the northern riffle shell *(Epioblasma rangiana)* in Ohio, the Higgins' eye pearly mussel *(Lampsilis higginsi)* in Illinois, and the mudpuppy mussel *(Simpsonichoncha ambigua)*, in Ontario which are indicated by shaded areas.

During the last 10,000 years few new species have evolved and thus become vulnerable to endangerment. One of these few is the Chittenango ovate amber snail, *Succinea ovalis chittenangoensis,* of New York (see shaded area). It has evolved in the spray zone talus under the falls for which it is named and has declined because of pollution in the spray. Apparently, there are a number of such postglacial species among certain plant and insect groups. If true, this would substantiate the popular notion that it is in the nature of insects to speciate.

Increased temperature does not appear to play nearly the role in the distribution of molluscan species which are endangered that it does for reptiles or plants. Note that there are as many endangered molcuscs in Idaho as in Arizona and in Tennessee as in Alabama.

cent of all species disappeared at the time of trilobite[4] extinction at the end of the Paleozoic era, about 230 million years ago; and 30 percent vanished at the time of the dinosaur extinctions at the end of the Mesozoic era, about 65 million years ago. Evidence indicates that during these periods the magnetic poles reversed so that there was little or no magnetic field for several thousand years. Great solar flares also occurred during these times. The ozone layers were depleted and radiation destroyed all but the well protected.

Growing appreciation for the potential value of all species coincided with their accelerating extinction rate and led to enactment of the Endangered Species Act of 1973. Administration of the Endangered Species Program is the responsibility of the Office of Endangered Species, a component of the U.S. Fish and Wildlife Service in the Department of the Interior.

This act is perhaps the most comprehensive environmental legislation to be passed by any country. It directs the government to use three direct methods to help prevent future extinctions: acquisition of endangered species' habitat, encouragement of conservation and habitat protection for listed species on Federally managed lands, and encouragement of individual States to enact and fund their own endangered species laws.

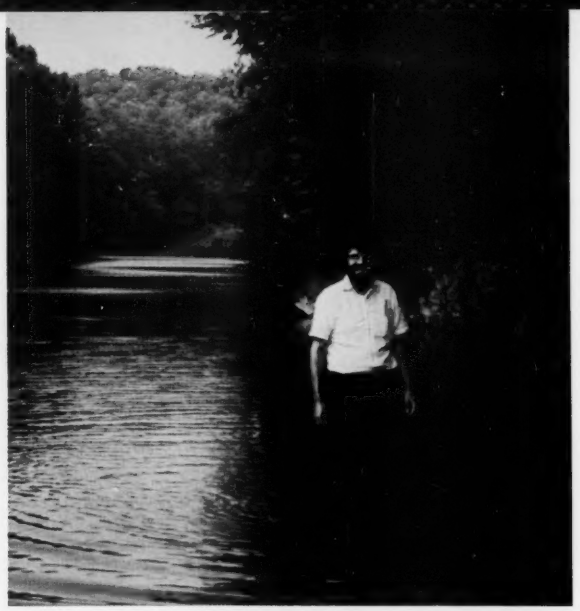
Section 4 of the act requires the Department of the Interior to publish lists of endangered and threatened species of creatures and plants. The lists differ essentially in priority. Those proposed as endangered are restricted to a very small area or occur in such small numbers as to be in imminent danger of extinction. The threatened list is for species that have a wider range or have sufficient numbers so that they face a less grave problem of survival but are likely to become endangered within the foreseeable future. Since the law was signed in December, 1973, 25 molluscs have been listed as endangered and 58 others have been proposed.

[4] A large class of marine anthropods whose bodies were divided by two furrows into three parts.

BOX SCORE OF WORLDWIDE SPECIES LISTINGS

Species	Endangered			Threatened		
	U.S.	Foreign	Total	U.S.	Foreign	Total
Mammals	36	215	251	1	3	4
Birds	65	144	209	1		1
Reptiles	8	46	54			
Amphibians	4	9	13			
Fishes	30	10	40	4		4
Snails		1	1			
Clams	22	2	24			
Crustaceans						
Insects	6		6	2		2
Plants						
Totals	171	427	598	8	3	11

Numbers of species currently proposed: 115 animals; approximately 1,850 plants



Author, shown here wading the Powell River in southwestern Virginia, was part of a group searching for endangered molluscs and fish.

All classifications of all plants and animals in the world are eligible for listing, including species, subspecies and isolated disjunct (disconnected) populations. Listing, delisting and reclassifying of endangered or threatened species may begin with a petition or a request from individuals or organizations or by initiative of the Service. Individuals and organizations must include supporting evidence with their requests. Before final listing, proposed endangered and threatened species are published in the *Federal Register*.

All Federal departments and agencies are required by section 7 of the act to insure that actions authorized, funded or carried out by them do not jeopardize the continued existence of listed species or result in the destruction or modification of their critical habitat.

The U.S. Fish and Wildlife Service has only some 180 law enforcement officers in the field, along with a few hundred field biologists. The 55 State and Territorial conservation agencies, by contrast, have well over 5,000 experienced conservation officers and several thousand professional wildlife biologists who are trained in the management of wild flora and fauna.

In June 1976, 11 States signed cooperative agreements with the Service, bringing a great many more specialists into the Endangered Species Program. Participating States are eligible to share about $2 million in Federal funds authorized to help them achieve their common conservation goals.

We have begun the task established by the legislation —development of methods to conserve the ecosystems on which endangered and threatened species depend. Much research lies ahead, however, because

the more we learn about our subject, the more complex it becomes.

Research has shown us, for example, that fire is necessary to the survival of certain land snails. When managed areas are kept free of fire for longer than the normal periods, the vegetation changes in character and the dependent land snail starves. During the fires, most of the snails survive by burrowing as deep as 5 feet beneath the forest floor. Alternatively, the snails living in areas adjacent to the burned lands eventually move in to eat the young vegetation which springs up.

Further research is needed before we will have the precise information needed to apply the finding that some molluscs need periodic fires to survive. Frequency and intensity of the fire and current humidity are all variables which have to be considered for each case. Apparently, this controlled fire is desirable in only 2 to 10 percent of our forested areas where the land snails depend on the type of vegetation which has evolved partially through the occurrence of natural fire.

A disturbance threshold determination is needed for forestry practices and other environment-altering activities which threaten species with starvation, hybridization and domination by introduced exotics (foreigners). We do not yet know what degree of selective harvesting is satisfactory for the survival of endangered land snails in forest cover.

For example, Pilsbry's narrow apertured land snail is restricted to the north side of Rich Mountain, Arkansas and Oklahoma, where it lives under heavy forest cover and in damp ravines. It can survive selective harvesting, but any major lumbering could destroy local populations and clear cutting would create major problems. On the other hand, the painted snake coiled forest snail, *Auguispira picta,* of Buck Creek Cove, Tennessee lives in an area where the more accessible portions are subject to periodic lumbering but the interior is so far undisturbed. It is not found in selectively lumbered habitats and thus cannot survive any lumbering.

Species such as the painted snake coiled forest snail are a good index of virgin conditions. Certain areas in the East have been abandoned for hundreds of years after clearing, farming and depletion of soil. Such areas may appear virgin to the unknowing eye but do not contain such species as the painted snake coiled forest snail.

Another of the activities needing a disturbance threshold determination is pollution. Biologists in Louisiana, Alabama and North and South Carolina, for instance, have found that not polluting may be our best defense against domination of the benthos[5] by the introduced exotic Asian clam, *Corbicula.*

[5] All life found at the bottom of a body of water.

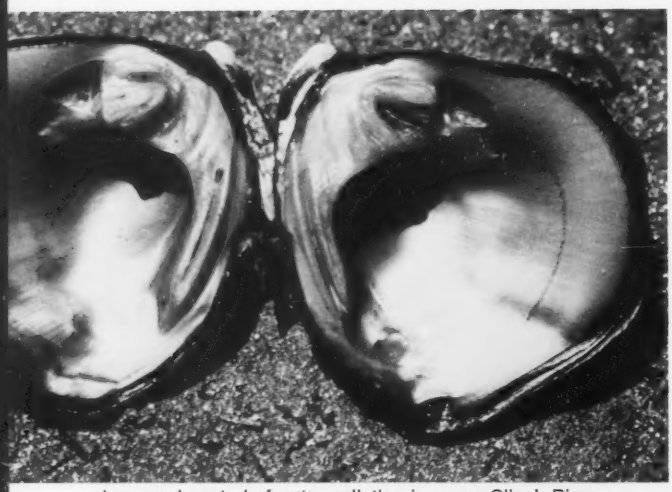
The North Carolina magnificent snail became extinct when lake shores were cleared of vegetation and ducks got them all.

Our experience to date clearly mandates an ecosystem approach to endangered species restoration. Pilsbry's narrow apertured land snail and the Rich Mountain salamander are both restricted to Rich Mountain. It is thought that the Rich Mountain salamander is especially adapted to capturing this snail. However, the snail's exceptionally narrow aperture is, in turn, extraordinarily modified for keeping out beetles and other snail predators.

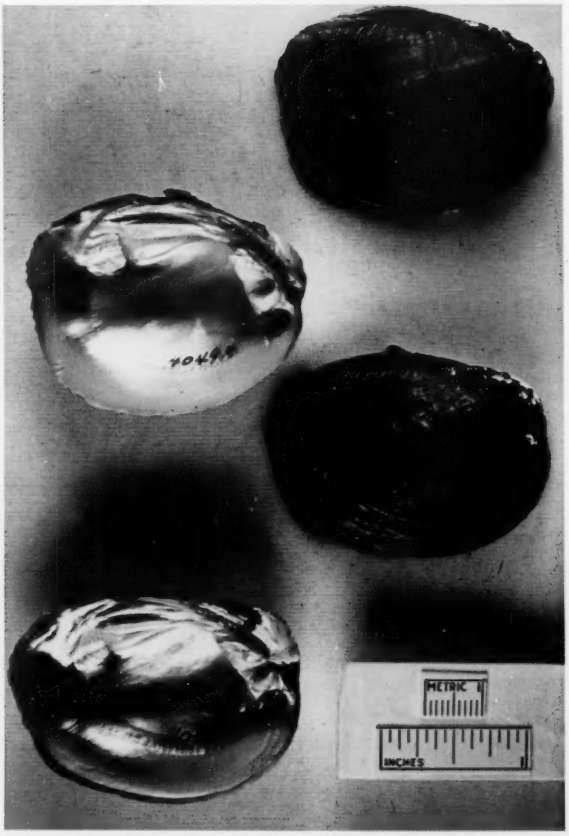
This type of interdependent relationship is working well in one small Texas ecosystem. The Diamond Y Pond snail, the Leon Creek pupfish and a small crustacean have been found living together there but nowhere else. Since species are interrelated and interdependent, introduction of one of these species elsewhere is unlikely to succeed.

Introduction is a bad word at the Office of Endangered Species but reintroduction is a good word since it involves rehabilitating the former range of a species. Preservation in aquaria, terraria and gardens, introduction outside of its native range and artificial mass production programs have proven chancy and subject to the whims of the budgetary process, especially during times of war or energy crises.

When species are transferred to new areas, their genetics change. Animals often grow bigger and some have been known to endanger other species of plants and animals. For instance, the introduction of the endangered Key Largo woodrat and Key Largo deermouse to Lignumvitae Key in Florida jeopardized *Liguus fasciatus lignumvitae,* a local tree snail.



Improved control of water pollution in upper Clinch River, Tennessee would also improve survival chances of resident species, including the pink pigtoe pearly mussel.



The acorn pearly mussel is restricted to 10 miles of the Clinch River in Virginia and is believed to be endangered by improperly treated municipal wastes. Already large beds of mussels have been wiped out.

Human beings and endangered species often compete for habitat and other resources. Depending on human uses and needs, measures to protect endangered species vary considerably in difficulty and cost. About one-third of the endangered species probably could be restored by relatively inexpensive means. Such measures might include modifying the boundaries of designated natural areas such as Mammoth Cave National Park in Kentucky or the proposed Channel Islands National Monument off the coast of California. Acquiring and protecting a number of caves or other small areas, each of which contains one or more endangered species, and additional management of parks and refuges are other options.

Another third of the endangered species are threatened principally by water pollution. Approximately 60 species of clams could be restored and protected by improved water pollution control efforts in five southern rivers: the Duck, Powell and Clinch Rivers in Virginia and Tennessee; the Green River in Kentucky; and the Altamaha River in Georgia.

The remaining third of these species would be considerably more difficult to protect. These are threatened by dams or other major projects. In most such cases, the conditions which have produced one unique species have also produced as many as a dozen or more endangered species such as bats, crayfish, plants and other distributionally limited species. Sometimes these concentrations of endangered species have simply evolved together as an adaption to a common unique habitat challenge such as an isolated cave system or the limestone talus that has built up under a waterfall. In other cases, they may belong to an isolated ecosystem left undisturbed by past glacial and volcanic activities. Others survive in the only remaining mature forest or unpolluted stream in a larger region. Such areas have numerous scenic or fish and wildlife values.

Almost all marine molluscs are not endangered at this time. These species are widely dispersed over areas of hundreds of miles, living in niches having common environments of temperature, salinity, nutrients and other characteristics. In the long run, perhaps 30 years from now, however, this pattern of dispersal will no longer protect marine molluscs. Pollution, plus other activities destructive to life, will have become so intense and pervasive in the oceans—which act as excellent carriers—that innumerable species will no longer be able to fend off these threats to their existence. They will go "all at once" so to speak. With them will go some of the strands in our web of life, leaving the rest of us more vulnerable by their passing. Failure to find the methods for keeping the web intact was described by the poet William Beebe in this way:

"The beauty and genius of a work of art may be reconceived, though its first material expression be destroyed; a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again." □

BRITAIN Pursues A National Water Policy

by D. L. Perridge
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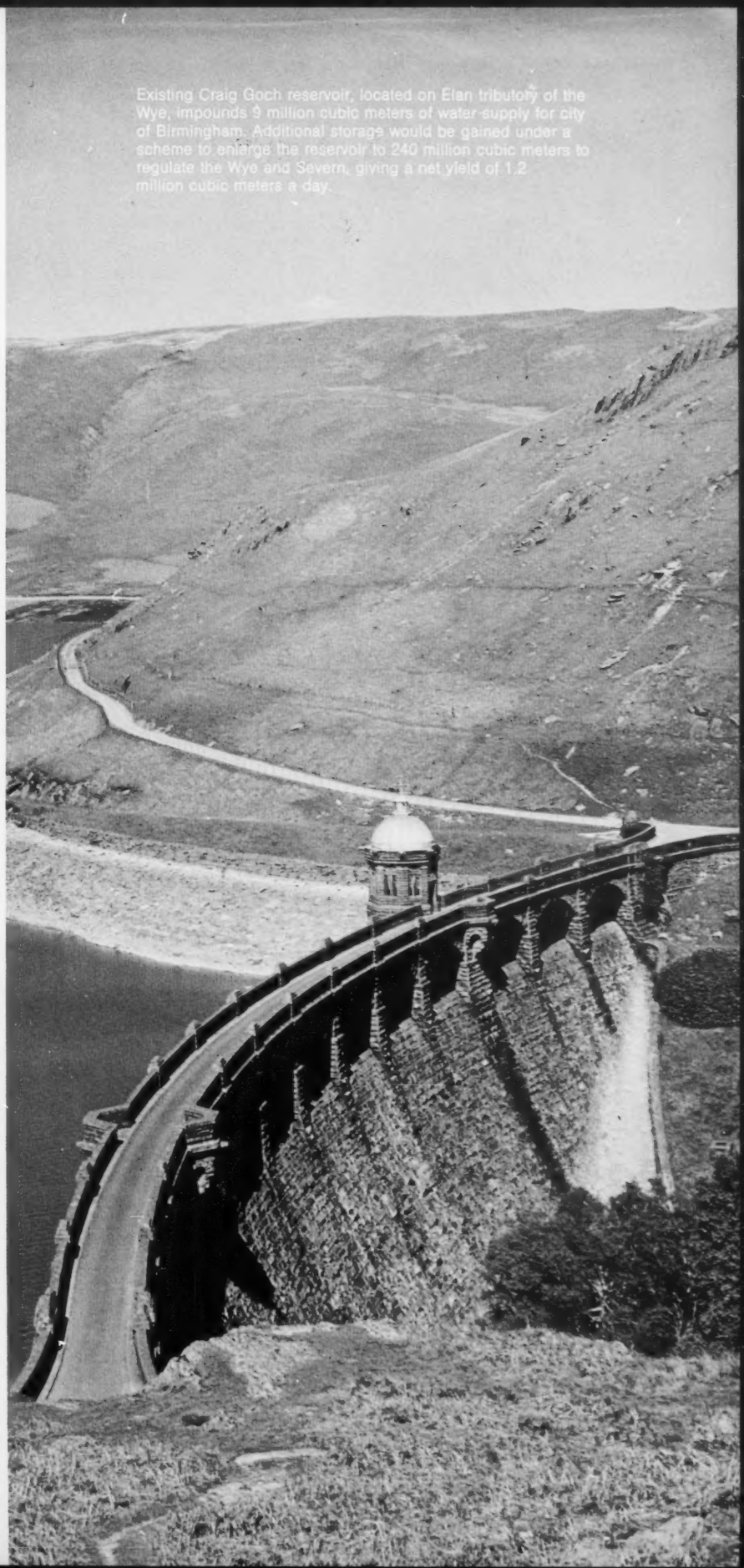
London, England



Existing Craig Goch reservoir, located on Elan tributory of the Wye, impounds 9 million cubic meters of water supply for city of Birmingham. Additional storage would be gained under a scheme to enlarge the reservoir to 240 million cubic meters to regulate the Wye and Severn, giving a net yield of 1.2 million cubic meters a day.

Evolution of the water industry in England and Wales during the past 150 years or so can best be understood as periods of adjustment to successive acts of governmental legislation. Such acts have been designed not only to meet emerging needs of the time but also to advance the construction of a coherent framework for the future.

Most recent is the 1973 Water Act, currently being reviewed by the government for possible further changes in the planning and administration of water resource programs. This act became effective on April 1, 1974 with establishment of the Welsh National Water Development Authority and nine companion regional water authorities throughout England.[1] Under the 1973 Act, each of the new authorities became responsible for all the water supply, sewage, sewage treatment, pollution prevention, fisheries and land drainage functions within its own geographical area. These functions previously had been shared among

[1] Administration of water services and the need for water resources development in Scotland and Northern Ireland are very different from those in England and Wales; therefore they are not included in this article. Also of interest is the fact that water resources in Scotland cannot be developed economically to meet demands in neighboring England.

An objective of the 1973 Water Act was to make widest possible use of water space for other purposes.

The trend toward formulation of a national water policy in Britain is of interest to fellow member-nations of PIANC, an organization whose aim is to maintain international communications relating to improvements in inland and ocean navigation.*

almost 200 separate water supply undertakings that included over 30 water companies, nearly 1,400 sewerage and sewage disposal authorities, and 29 river authorities.

For the first time a single authority became responsible for all aspects of the water cycle. The accompanying reorganization left water supply companies in being, but as agents of the water authorities. Sewerage management has been continued by the district councils and the London boroughs under a similar agreement.

The 1973 Act that established the 10 water authorities was but the most recent step in a continuing process of rationalizing the water industry in Britain. Ten years earlier the 1963 Water Resources Act had established 29 river authorities, all now part of the current 10 regional water authorities. Meanwhile by 1970, voluntary amalgamations had reduced to 220 the 1,186 separate water supply undertakings that existed in 1945.

Under the earlier 1963 Act, the former 29 river authorities had been directed to introduce both a licensing system for all water withdrawals and a system of charges to finance their activities. A Water Resources Board (WRB) was set up to advise the river authorities on their functions and the governmental ministers on matters of policy.

The WRB soon became involved in regional planning, producing three regional water resource studies for the North, Wales and the Midlands, and Southeast England. These studies were drawn together in a report referred to as the National Study, which presented their findings as a coherent whole related to the new water authority boundaries established under the 1973 Act.

Basically, the National Study proposed a strategy for developing new sources of water supply beyond the year 2000. This strategy provided the foundation for many of the plans being developed by the individual water authorities and was based on the following general principles adopted by the WRB:

—alternative resource sources should be grouped into coherent development programs, not treated in isolation

—flexibility is necessary in matching resources to demands

—storage, whether surface or underground, should be used to regulate rivers, which should themselves be used for conveyance

—consideration of any scheme should include social costs and benefits as well as direct cost and technical merits

—reservoirs should cause the minimum disturbance, direct or indirect, to existing land use.

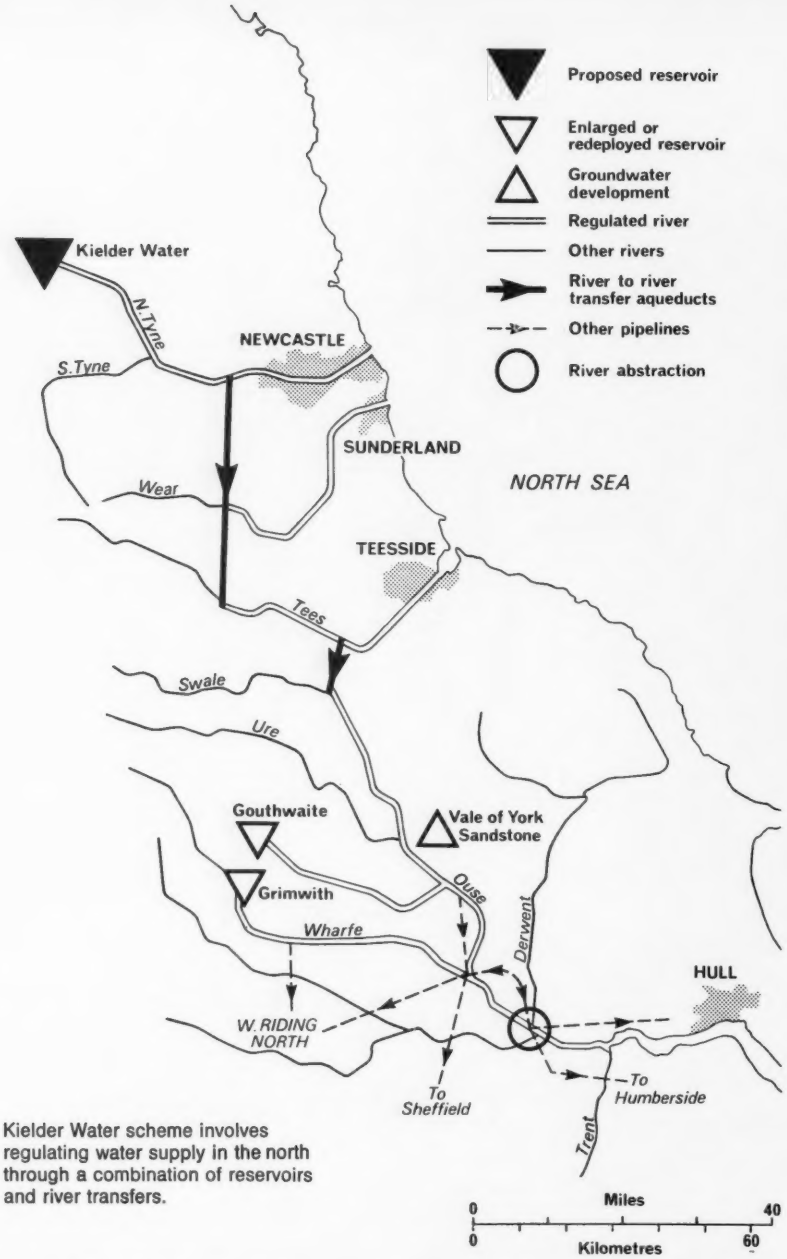
It would have been an impossible task to devise a national strategy that would have taken into account the separate resources and demand projections of each of the 200 water undertakings. Some simplification of the problem was necessary and it was achieved in two ways. First, some areas were excluded as either already self-sufficient in water resources or unable to contribute cheaply to other areas. Second, all demands were aggregated into *demand centers,* each located at the demand "center of gravity" for their constituents. The resource allocation problem then became one simply of meeting in an economical way the deficiency of each of the demand centers. This deficiency was defined as equivalent to the excess of demand forecasts over existing resources.

Here again the resource-demand problem had already been simplified by the previous work of the river authorities through their investigation of possible water resource development schemes. The river authorities had also established the feasibility, size and estimated costs —both capital and running—of source and transmission works. There existed, therefore, a ready-made list of schemes on which the National Study could be based, but there still remained a formidable problem of choice, which led to development of two models.

An analytical model was designed

* The Permanent International Association of Navigation Congresses convenes quadrennually in a member country. See *Water Spectrum,* Winter 1975-76, page 30.

Preferred strategy of resource development in England and Wales.



Kielder Water scheme involves regulating water supply in the north through a combination of reservoirs and river transfers.

to optimize the choice of schemes, the order and timing of their development, and the allocation of resources to the demand centers by an integer programming technique.

A simulation model, a matter of engineering judgment, was supplied with definitions of system parameters and a resource development program. This model compared the costs of meeting demands from the various resources, ranked the preference of each demand for particular resources, allocated demand according to ranking, calculated flows in order to determine optimum staging of pipeline and pump installations and, finally, computed the costs—both capital and running—arising in each year of the study together with the present value cost by using a test discount rate.

The schemes considered for the national strategy included use of surface water, groundwater, estuary storage and desalination, with variations in each type. Surface water schemes included direct withdrawal from rivers and the use of reservoirs filled naturally, or by pumping or diversion from other drainage basins. Generally, reservoirs would not be used for direct supply but for regulating rivers, often in conjunction with other resources.

The groundwater schemes included consideration of artificial recharge, although the application of this technique appears to be several years off. Estuary storage schemes were the subject of special studies because of the complexity of issues involved that were not directly related to water supply engineering.

Strategies for the Future

Overall, the National Study was concerned with a short-term plan for 1981 and a longer term plan extending to 2001 or beyond. At the time of the study's completion, the demand for water was expected to double between 1971 and 2001. Although such an increase is thought unlikely now, this national strategy was subjected to sensitivity tests. The reduced demands foreseen today do not upset any of the decisions about choice of schemes, but merely defer the implementation dates.

Each of the possible development strategies that follow also have alternative programs that were considered in putting them together.

Strategy	*Description*
A	Inland storage
B	Estuary storage
C	Combined inland and estuary storage
D	Programs including artificial recharge and river reclamation
E	Program including desalination
F	Immediate regional self-sufficiency
G	Regional self-sufficiency after 1981

Strategy A, the cheapest program, called for the enlargement of three existing reservoirs and the creation of seven new reservoirs. Alternative programs would reduce the number of new reservoirs, but at some additional cost for this plan.

In strategy B, all new storage

after 1981 was to be provided by estuary schemes. Programs within this strategy were more expensive and the ecological effects would have been severe.

Strategy C, which provided a balanced combination of A and B, was preferred by the WRB. This strategy made maximum use of groundwater along with enlargement and redeployment of existing reservoirs. It required a limited number of new inland reservoirs and entailed major transfer works. Estuary storage was restricted to one development at a time.

The WRB examined nine programs within strategy C, three more under strategy D, which was a modification of C and took into account the possibility that artificial recharge of the London basin and reclamation of the Trent would become practicable within the planning period.

Use of desalination was considered in strategy E to compensate for the water deficiencies in central Southeast England after 1981, but the cost was determined to be excessive.

Strategies F and G reflected, to different degrees, the restrictions on the transfer of water. Both strategies produced a need for many more reservoirs and resulted in considerably higher costs because of their inherent lack of flexibility.

Toward A National Water Policy

The 1973 Act, which came into effect shortly after publication of the National Study, imposed a duty on the government to promote and execute a national water policy. Objectives of the act were securing an ample water supply to meet growing demands, providing adequate sewerage and sewage disposal facilities to cope with the natural increase in water use, maintaining and expanding land drainage and flood protection to urban and agricultural areas, achieving a massive cleanup of rivers and estuaries by the early 1980s, making widest use of water for multiple purposes, and protecting the interests of those affected by water resources development proposals.

A proposal to raise the height of this historic masonry dam at Vyrnwy would require partial resiting of nearby village.

In forming the current water authorities, the 1973 Act required the authorities to do four things:

—survey existing water use, quality and management

—prepare medium-term programs

—prepare long-term, 20-year estimates

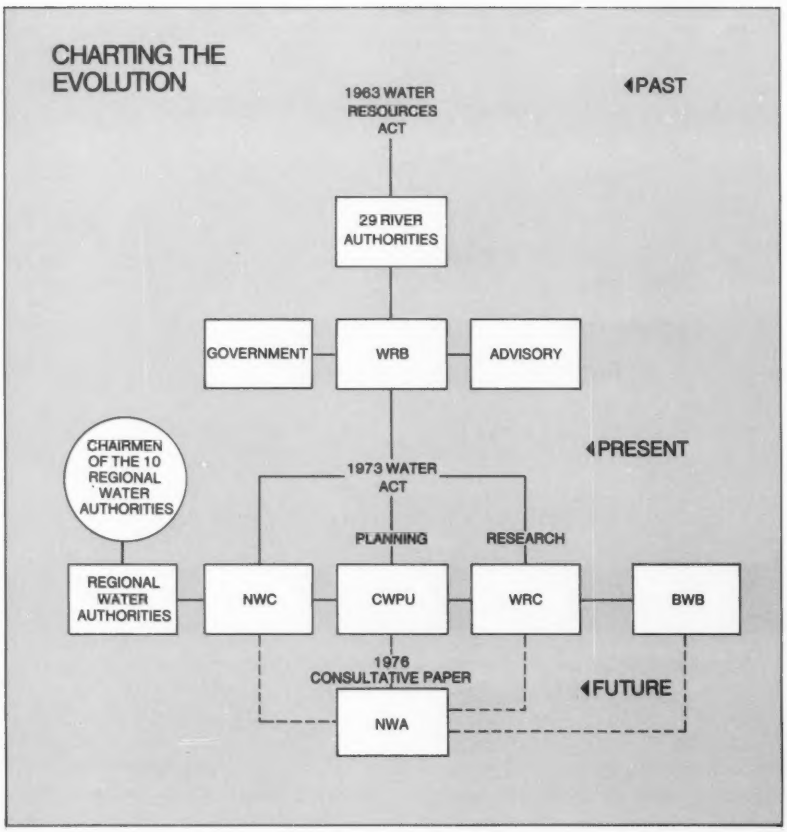
—prepare a plan of action to meet future demands and maintain or restore water quality within their respective areas.

The long-term 20-year programs and the action plans required by the act include consideration of water quality, navigation, recreation and scenic amenities. In addition, each regional authority must consult with the local authorities in regard to development proposals within its jurisdiction and submit its program for annual capital expenditures to the government for approval.

Establishment of the regional water authorities coincided with the transferring of the WRB's planning duties to a new Central Water Planning Unit (CWPU). Meanwhile, the research interests of the WRB were merged with the government's Water Pollution Research Laboratory and Water Research Association into a new Water Research Centre (WRC), jointly financed by the water authorities and direct commissions.

The chairmen of the 10 water authorities, appointed by the government's ministers, serve as members of the National Water Council (NWC), whose chairman also is appointed by the government. As both a forum for discussion and a policy advisory group, the council brings together representatives of the water authorities for decisions on how far to follow the principles and strategies developed by the former WRB; whereas the CWPU that replaced the WRB provides a national strategy review of all water planning and operations for the 10 water authorities, the council and the government.

A new administration has come into the government since passage of the 1973 Water Act and has invited comment on a consultative



reservoir of 186 million cubic meters to regulate the flow of three, possibly four, rivers. This would give a net yield of 955,000 cubic meters a day.

To begin with, releases into the North Tyne from the reservoir would flow down to regulate the Tyne, from which withdrawals would be made for three purposes:

—to supply the Newcastle area

—to regulate the Wear by transferring water through a 25-kilometer pipeline and tunnel aqueduct

—to regulate the Tees by transferring the water an additional 14 kilometers through a second tunnel

Withdrawals from the Wear and the Tees would be used to supply the Sunderland and Teesside areas, respectively. As a final stage of this scheme, additional water withdrawn from the Tees might be transferred by pipeline to the Swale in order to regulate that northern tributary of the Yorkshire Ouse, from

paper discussing current issues and proposals relating to the water industry. Called a "Review of the Water Industry in England and Wales," this paper was published in March 1976. One of its key proposals is that the NWC, WRC and CWPU all be replaced by a National Water Authority (NWA), which would fill an existing vacuum in planning at the national level. Its proposed duties are listed in the accompanying box.

Other proposals include integrating the local water companies with the regional authorities, equalizing water charges across the country and merging the existing British Waterways Board (BWB) into the proposed NWA. BWB is presently a nationalized industry managing 3,000 kilometers of waterway, of which about 2,500 kilometers are navigable. The regional water authorities manage navigation for some 800 kilometers of river, while an additional 800 kilometers of waterways are managed by a variety of other bodies. A merger, therefore, would make it easier to implement both the navigational and recreational aspects of a national water policy.

The latest proposals also would strengthen the industry's central planning capability and ensure that plans are carried out in line with a national policy. *The concept of an integrated approach to water management covering all aspects of the water cycle remains the cornerstone of government policy.*

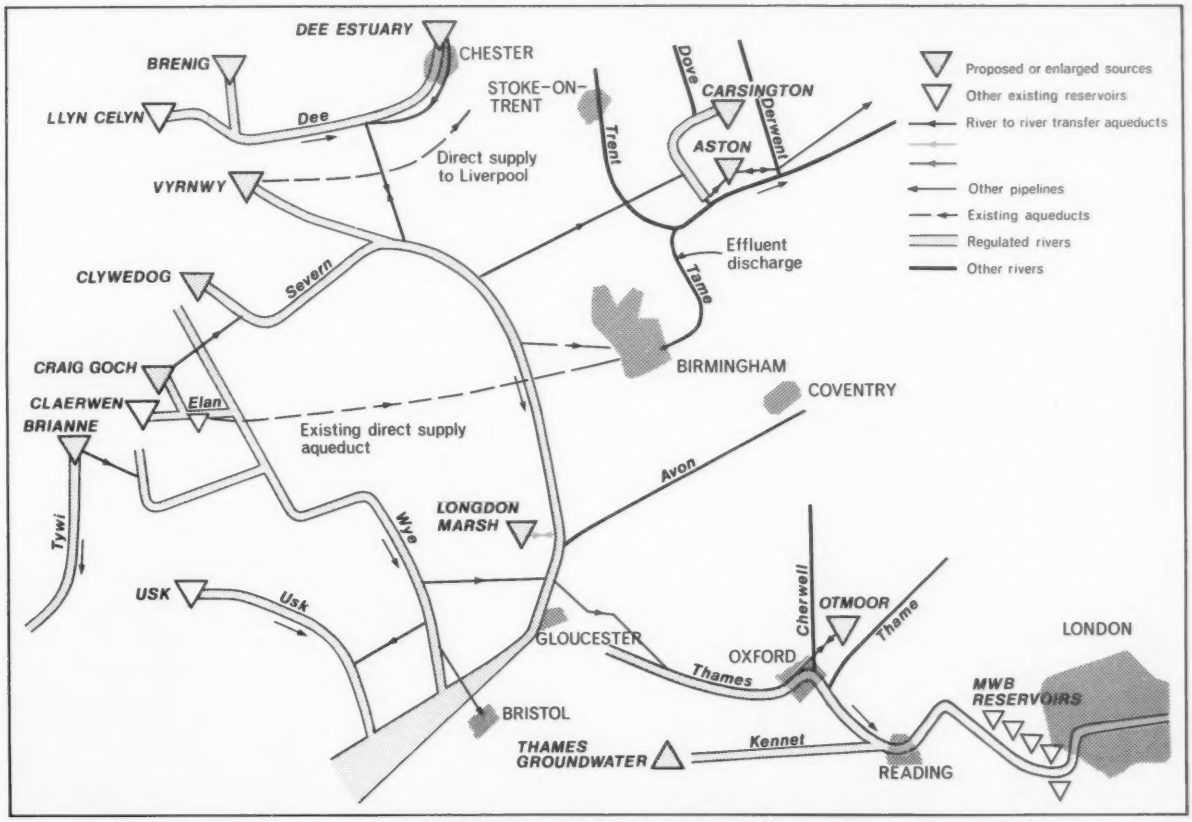
Priority Schemes

Under the possible development strategies offered earlier by the National Study, the following schemes are among the preferred programs selected for priority implementation.

The Kielder Water Scheme proposed for northern England calls for creation on the North Tyne of a

Duties of Proposed National Water Authority

1. Prepare national strategy.
2. Lay down scope and minimum content of long-term plans that the regional authorities prepare.
3. Either endorse plans or ask regional authorities to amend them.
4. Advise government ministers on medium-term plans and annual submissions of general program.
5. Prepare annual submission of a national capital investment program to government ministers.
6. Recommend transfers of water and resource redeployments among regional authorities in accordance with national strategy.
7. Implement those schemes endorsed by the ministers as part of the national strategy.



Craig Goch scheme would permit water to be conveyed across Britain by transfer from lower reaches of the Severn into upper reaches of the Thames. Withdrawals would be made downstream of the treated effluent from the Birmingham area at Longdon Marsh. Besides supplying the demand centers of Birmingham, Stoke and Gloucester, water from the Severn would be taken as far north as Liverpool and as far east as Coventry.

whose downstream reaches water is withdrawn for the West Riding, Hull and Humberside, and Sheffield areas.

This scheme well illustrates some of the principles on which the former WRB's strategy was based, particularly the use of stored water to regulate rivers for withdrawals by downstream demand centers. The scheme, therefore, also shows the flexible matching of resources to demands.

Less obvious is the application of the principle that reservoirs should cause the minimum disturbance, which only becomes apparent when the alternatives to the Kielder water scheme, involving multiple reservoirs, are examined. The amenity aspects, including provision of recreation facilities and nature reserves, have also been considered and planned from the earliest stages.

Redevelopment of existing storage has been proposed for a number of reservoirs to procure useful gains in yield. Compared with its originally conceived operation, the reservoir on the Vyrnwy has two possibilities for increasing the yield. A gain of 25,000 cubic meters a day would come from altering the rules for releasing compensation water. A further 10,000 cubic meters a day would be gained by using the storage water for river regulation instead of directly supplying 210,000 cubic meters a day to downstream users.

In the case of Vyrnwy there is the additional option of raising the dam by 17 meters, thereby increasing yield by another 730,000 cubic meters a day. However, the existing dam, having been completed in 1891, is of considerable historic interest, as it was the first major masonry dam built in Britain. A companion objection to an enlargement of this reservoir would be the need to resite much of a nearby village.

A pilot scale development has been carried out for two groundwater withdrawal schemes that are now in their initial stage of full development. The first scheme is to increase the low flow in the Thames by pumping water from the beds of oolite and chalk limestone underlying the area. This scheme can deliver a net yield of 455,000 cubic meters a day when fully developed.

The second scheme is to regulate the Ouse in East Anglia by withdrawing water from the underground layers of chalk at a net yield of 330,000 cubic meters a day. For the full benefit of this scheme to be realized, the residual flow (water remaining for amenity, fisheries, effluent dilution, etc.) in the lower reaches must be reduced. Alterna-

Inserting soil-water level tube is a preparatory part of Great Ouse groundwater pilot scheme to withdraw water from underground layers of chalk.

Dee estuary is most likely site for reservoir development scheme among the five estuaries investigated.

tive means of disposing of industrial effluent on the lower Ouse must be found, however, before such a reduction can be allowed.

Another component of the WRB's national strategy is a high degree of regulation for the Severn. This could be achieved by the Craig Goch scheme, which would involve a massive enlargement of an existing reservoir on the Elan tributary of the Wye in Wales. The Craig Goch reservoir now impounds 9 million cubic meters of water for direct supply to Birmingham, a supply which would be maintained. The additional storage gained from enlarging the reservoir to 240 million cubic meters would be used to regulate the Wye and Severn, giving a net yield of 1.2 million cubic meters a day. Withdrawals from the regulated Severn would be taken as far north as Liverpool and as far east as Coventry, as well as being used to supply the demand centers of Stoke, Birmingham and Gloucester.

Water could be conveyed west to east across practically the whole of Britain by transfer from the Severn's lower reaches into the upper reaches of the Thames. Such withdrawals could be made downstream of the substantial amounts of treated effluent coming from the Birmingham and Worcester areas as part of a pumped-storage installation at Longdon Marsh. This scheme's potential yield of 660,000 cubic meters a day also could support withdrawals for the benefit of the Coventry area.

The estuaries of some rivers can provide potential reservoir sites. At one time or another five such schemes have been investigated. A dam across the Solway estuary on the border with Scotland would provide relatively cheap storage, but the cost of conveying the water to the centers of demand makes this scheme uneconomical as a whole. A possible scheme for the Severn estuary also was found to be too expensive.

The remaining three sites — Morecambe Bay, the Dee and the Wash—appear economically attractive enough to warrant detailed examination. Of these, the Dee is most likely to be developed and is capable of yielding up to 1.08 million cubic meters a day. Four embanked reservoirs, to be constructed near the head of the estuary, would be filled by pumping from the Dee at a point upstream of a tidal barrier.

Present Problem

Runoff in the driest single month is expected to drop to 10 percent of the average daily runoff over the country as a whole only once or twice in a century. In April 1976 some parts of southern England received less than 10 percent of the average rainfall, and during the 12-month period ending that month rainfall throughout England was only 68 percent of average and the lowest since record keeping began in 1727.

Runoff varies from well over 4,000 millimeters to less than 100 millimeters from west to east. With the most heavily populated regions of the Midlands and the Southeast in the drier eastern half, there is a need for storage and transfer of water that will continue to increase with the growth of demand.

The National Water Authority, which has been proposed as a central coordinating body, will substantially strengthen planning capability at the national level. Based on a natural continuation of the National Study, the strategy to be developed will provide a flexible framework for the regional water authorities. Thus, specific local issues can be assessed against national criteria aimed at guaranteeing the multiple use of water for the greatest common good. The proposals associated with creation of this central coordinating body are designed to ensure that Britain's resources are developed to meet the growing demands projected for the remainder of the century and beyond. □

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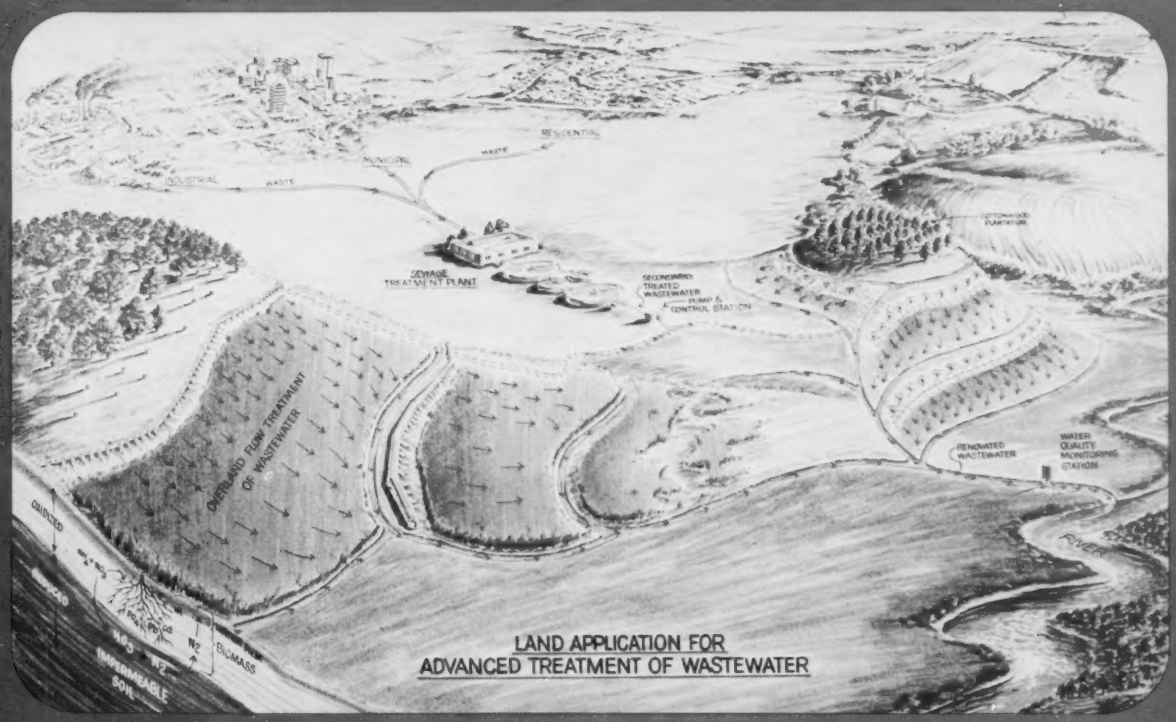
Update: Overland Flow

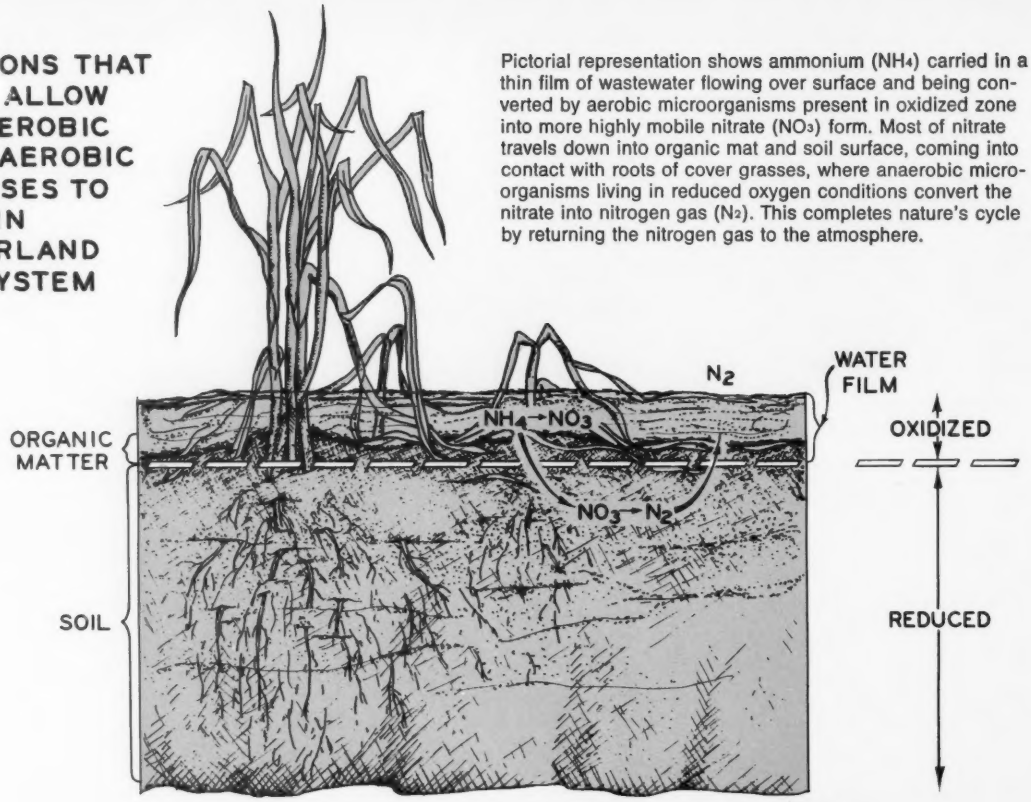
By P. G. Hunt, C. R. Lee, and R. E. Peters



LAND APPLICATION FOR
ADVANCED TREATMENT OF WASTEWATER

Applying wastewater to land renovates or cleanses the water through its interaction with the soil itself, the microorganisms living in the soil and the surface crops. One of the popular aspects of land application is its very simple and appealing philosophy: "Use the water and nutrients of wastewater as a resource." Rates of application can be managed so that optimum water renovation and crop production are achieved. Additionally, the renovated water may be reused for functions such as cooling in industrial processes and aquifer recharge, or it can be discharged into streams without disrupting their water quality and aesthetic appeal.

CONDITIONS THAT WOULD ALLOW BOTH AEROBIC AND ANAEROBIC PROCESSES TO OCCUR IN AN OVERLAND FLOW SYSTEM



Pictorial representation shows ammonium (NH_4) carried in a thin film of wastewater flowing over surface and being converted by aerobic microorganisms present in oxidized zone into more highly mobile nitrate (NO_3) form. Most of nitrate travels down into organic mat and soil surface, coming into contact with roots of cover grasses, where anaerobic microorganisms living in reduced oxygen conditions convert the nitrate into nitrogen gas (N_2). This completes nature's cycle by returning the nitrogen gas to the atmosphere.

Probably no aspect of improving the Nation's environmental quality has received more attention than the treatment of municipal wastewaters. Land application, one of the oldest forms of land treatment, has received a considerable amount of this attention due to its increasing appeal to communities looking for a practical as well as cost-effective treatment approach.

Of the three distinct types of land treatment systems —rapid infiltration/percolation, crop irrigation and overland flow—overland flow is the most effective method to use in locations with soils of low permeability. These soils of clay, silty clay, silty loam and soils with barriers such as hardpans have a rather low infiltration capacity and are found throughout most of the United States.

Operating Systems

One of the oldest overland flow systems in the world is located at Melbourne, Australia.[1] Dating back to 1898, it is referred to as grass filtration by the Australians. The Melbourne system differs from American systems, however, because it uses raw or untreated wastewater for part of its operation. In this country, the overland flow method has been used to provide an advanced level of treatment to wastewater that has already received primary and secondary treatment.

Small as well as large cities can use land treatment effectively, but the decision to use this type should be based on the presence of the right combination of factors to make land treatment cost effective. Often the cost-effective aspect is most apparent in systems designed for small cities and recreational areas.

Overland flow treatment was first used in this country in the early 1950s by the Campbell Soup Company at Napoleon, Ohio. The company discovered the concept while augmenting their Napoleon trickling filter facility with a land treatment system in order to accommodate peak loads from their tomato-processing and soup-manufacturing plants. Their initial pilot studies produced good results; however, the wastewater loads in 1954 and

[1] "Waste into Wealth," which appeared in the Fall 1972 *Water Spectrum*, contains a description of the Melbourne and Metropolitan Board of Works Farm sewage treatment facility in Australia.

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1955 were excessive and caused runoff and ponding to occur—conditions that would be classified as system failure. Fortunately, it was discovered that in areas where the wastewater flowed over the soil surface in a uniform thin film, the biochemical oxygen demand (BOD)[2] was reduced by more than 90 percent.

The general workability and reliability of overland flow were then proven even more strongly by the Campbell Soup Company at Paris, Texas in 1960. Based on the earlier results of the Napoleon system, company personnel decided to construct an overland flow system on a 600-acre site in Paris to renovate the wastewater from their soup production plant. The soil at the site was a severely eroded clay with a very low infiltration capacity. Considerable earth work was required to obtain the desired, uniformly smooth soil surfaces on gentle slopes. Similar earth work was also required in 1976 for a 250-acre expansion of the system.

Earlier Research Experiments

The Paris system functioned well for reduction in wastewater BOD and total suspended solids, as did the other systems. However, concern existed about the system's performance in nutrient removal, especially in light of increasingly stringent water-quality standards. To address this concern, the Environmental Protection Agency's (EPA) Robert Kerr Water Research Center, in conjunction with the Campbell Soup Company and North Texas State University, conducted an extensive study of the facility in 1968 to determine if organic material and nutrients were being flushed from the system.

The experimental areas at Paris had slopes with 2- to 6-percent inclination and were 150 to 300 feet in length. Application rates varied from 0.25 to 0.50 inches per day with application periods of 6 to 8 hours. The BOD removal was very good with greater than 99-percent removal in many cases. As expected, the microbial population responded extremely well to the easily degradable organic components applied in the wastewater. Populations in the test plots were always higher than those in a control plot.

In addition to the expected high removal of BOD, there was a greater than 90-percent removal of nitrogen. This was a very interesting phenomenon since the wastewater moved across the soil surface and supposedly did not interact extensively with plant roots, soil particles, or anaerobic (surviving without oxygen) microsites. However, a detailed analysis for nitrogen revealed a significant amount of nitrogen loss by denitrification.[3] Phosphorus removal was found to be low, probably due to lack of contact between the wastewater and soil particles as well as to the flooded conditions and reduced nature (lack of oxygen) of the soil.

In addition to cooperating with the research at Paris, Texas, the EPA center conducted extensive field plot experimentation with the treatment of both raw and primary wastewaters. These studies showed very good performance and indicated that overland flow was indeed a good method of treatment for municipal wastewater. The U.S. Army Engineer Waterways Experiment Station (WES) took the concept one step further by demonstrating in greenhouse model studies the high level of advanced treatment obtained by treating secondary wastewater via overland flow. A workable theory for the general chemical-biological functioning of an overland flow system was developed.

Normally disinfected secondary-treated wastewaters are applied at the top of slopes ranging from 150 to 300 feet in length. On soils that are quite low in permeability, the slope must be great enough to prevent puddling but not so steep as to cause insufficient soil contact for treatment. As the wastewater passes over the soil and through the organic mat, it interacts with the soil, plant roots, and microorganisms and is renovated.

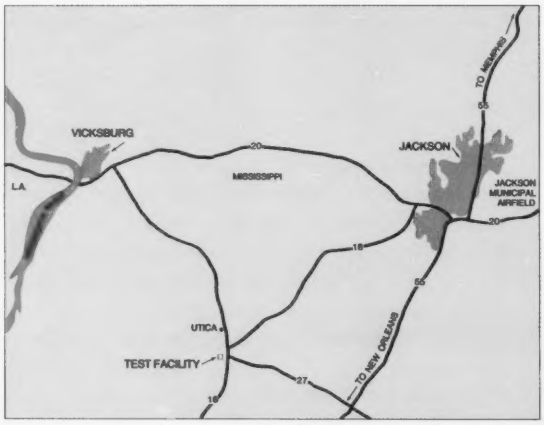
In an effort to ensure that land treatment systems are planned and designed properly, the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency have joined in an effort to produce a comprehensive design manual. One of the major areas to be addressed in the manual is treatment of wastewater on soils of low permeability, or overland flow. *Water Spectrum* has published several articles on the general approach to land treatment of wastewater; one of them ended with the following paragraph:

"Although overland flow has not been used as extensively as rapid infiltration or crop irrigation, it appears to be a sound method of treating wastewater to advanced levels. Certainly, there is as much information and experience concerning overland flow treatment of wastewater as there is for many other forms of advanced treatment of wastewater presently being considered by municipalities and wastewater treatment consultants. Consequently, any municipality with substantial areas of low-permeability soil in reasonable proximity to the metropolitan area should consider overland flow as an advanced wastewater treatment alternative."[4]

[2] BOD represents the amount of oxygen required by natural biological processes to oxidize the organic material in a sample of wastewater.

[3] A biological process that results in the escape of nitrogen into the air.

[4] The article, "Overland Flow," was published in Vol. 5, No. 4, 1973.



Preparation of Utica test site required compacting, replacing topsoil, grading slopes and seeding.

THE UTICA EXPERIMENT

At this time overland flow is considered to be a reliable form of advanced wastewater treatment, and implementation of a number of cost-saving improvements appears to be possible. To this end both the Corps of Engineers and EPA are conducting complementary research on prototype overland flow systems. Major research is being conducted by the Corps of Engineers at Utica, Mississippi, and by EPA at Ada and Paul's Valley, Oklahoma, and Easley, South Carolina.

The project near the small rural community of Utica, Mississippi (population 1,000) is jointly funded by EPA and the Corps of Engineers. It is conducted in cooperation with the town of Utica and a local landowner.

The first phase was begun in 1975 with construction of the facility and the overland flow system. The site was selected and prepared to obtain the desired degree and length of slope for the treatment areas. The required amount of site preparation, and thus construction costs, was reduced by carefully selecting a site that had naturally sloping land at or near the 2-, 4- and 8-percent slopes desired for the study. However, the permeability of the soil at the site was somewhat more variable than desired for research. To overcome this problem and to

establish more uniform conditions, the test area was prepared by removing the topsoil and compacting a subgrade to about 95 percent of optimum density. Compaction also allowed for the simulation of treatment on soils containing hardpans. After compaction, the topsoil was replaced and finished to slopes of 2, 4 and 8 percent.

Twenty-four research plots measuring 150 by 15 feet were prepared and seeded with a mixture of four grasses: reed canary, Kentucky fescue, perennial ryegrass and common bermuda. Reed canary grass has proven to be an effective vegetative cover for overland flow systems throughout the Nation. Fescue and ryegrass provide a cover for the cooler fall and winter months, while the bermuda is particularly well suited for hot southern summer climates.

The Utica operation starts at the 6-acre municipal lagoon from which wastewater is pumped to a centrally located chlorine contact tank. There the wastewater content is changed by adding nitrogen, phosphorus, and trace elements (heavy metals) in order to make Utica's wastewater correspond more closely to wastewater from a heavily loaded municipal system with a significant industrial input. Application periods are regulated according to a predetermined schedule by timers that activate the system pump and the solenoid valve of each plot. A trough applicator uniformly applies wastewater to the top of each slope. Runoff is captured at the bottom of each plot and pumped through a water meter to allow measurement of runoff volume. Subsamples of runoff waters are collected for determination of chemical and biological components.

Phase II and Beyond

Results of the initial phase showed extremely good treatment for nitrogen. Phosphorus removal was predictably low, and heavy metal removal has not yet been evaluated. Since the WES greenhouse model studies showed that heavy metals were quickly and tenaciously held in the surface organic mat, heavy metal removal is expected to be excellent. However, the effect of heavy metal accumulation on the land treatment system will have to be investigated.

Enhancing phosphorus removal by adding aluminum sulfate to the wastewater is another process that will be further investigated. Results of WES and EPA studies indicate that phosphorus removal can easily be increased to greater than 90 percent by adding aluminum sulfate. As with heavy metal accumulation, the long-term additions of aluminum phosphate to the soil surface must be investigated.

Public health aspects of transmission of pathogenic indicator organisms (those capable of causing disease) through an overland flow system are also being researched. These studies will supply quantitative measures of the effectiveness of overland flow in removing pathogenic indicators from wastewater.

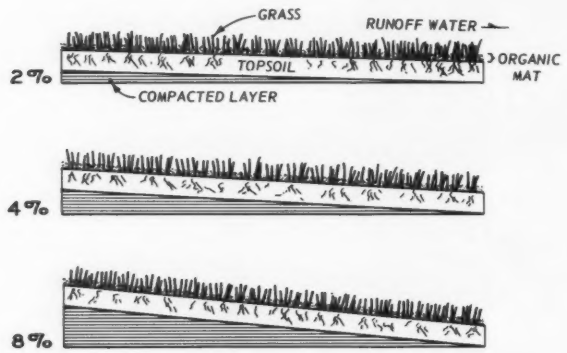
Another important aspect of potential pathogenic

Trough applicators were chosen to distribute wastewater at Utica site.

Rotating boom sprinklers distribute either raw sewage or primary and secondary treated effluent at Robert S. Kerr Environmental Research Laboratory site near Ada, Oklahoma.

Fixed risers spray effluent drawn from wastewater lagoon at Paul's Valley,Oklahoma site operated by EPA.

Layout of Utica's overland flow land treatment system depicts locations of slopes. Wastewater pumped from lagoon on demand enters chlorine contact mixing chamber, where nutrients and heavy metals are added before water reaches troughs. Discharges are metered at bottom of each slope.



Sectionals illustrate composition and relative slopes of typical test plots at Utica.

transmission is depicted in the accompanying illustrations of application techniques. Obviously, the trough or gated pipe application will result in transmission of fewer aerosols since wastewater is never sprayed into the air. However, wastewater application via this method requires a more uniform slope to obtain an even distribution of water than does the rotating pipe or spray applicator.

The level of wastewater treatment achieved can be determined only when the volume and composition of wastewater are known at the system's points of application and runoff. This is easier to determine for overland flow than for other methods because of the substantial portion of water that flows over the soil surface. With most operating systems that have clay soils, most of the wastewater is accounted for by monitoring the runoff and effectively measuring the evapotranspiration. Research studies and systems located on more permeable soils must, however, have an estimate of the subflow component that percolates into the ground. One of the active components of the Corps of Engineers wastewater research program is the development of a water flow model. Data from Utica and other facilities will be used to validate and refine this mathematical model.

In addition to monitoring the treatment site's runoff water during normal wastewater application, studies are planned to assess the quality of the runoff water during periods of rainfall. These studies should determine

Water sampler, and grass harvester at work.

whether an intense storm event will cause a significant "flush" or removal of contaminants from the site.

Two of the most important factors in an overland system are the type of vegetative cover and its management. The vegetative cover not only significantly affects the amount and composition of runoff from both applied wastewater and storms, but it also forms the organic mat—the single most important treatment component of an overland flow system. Surface plants also remove nutrients and heavy metals from the applied wastewater and soil and constitute a marketable product of the land treatment system.

The predominant cover for overland flow systems has been reed canary grass, a plant that is tolerant of both cold weather and flooded soil. Ryegrass and fescue have also been used, but normally only during the initial stages of an overland flow system. Reed canary grass will predominate after a few years if there is no additional overseeding with ryegrass. However, an overseeding of ryegrass after the fall harvest of reed canary grass would appear to enhance wastewater treatment during the winter months. At the Utica overland flow research facility, the effect of plant composition on water quality will be tested during various times of the year.

Technology transfer is an important part of any research project. A number of mayors, scientists, engineers and foreign visitors have already toured the overland flow facility at Utica;[5] and a field day is scheduled for April. Information and public awareness are also being generated by EPA at its research facilities. If acceptance of the overland flow treatment of wastewater has not yet arrived at American municipalities, demonstrations such as the Utica system are providing interested persons with the opportunity to become more familiar with this land treatment process. □

Wastewaters containing domestic, industrial and agricultural effluents can be treated by several processes and combinations of processes. These provide levels or degrees of treatment. Primary treatment, through grinding, skimming or sedimentation, generally reduces by 50 to 60 percent the suspended solids and by 30 to 40 percent the biological oxygen demand (BOD) found in raw wastewater.

Secondary treatment plants use biochemical processes to further reduce the waters' organic load, or BOD. Removals of 80 to 90 percent can be achieved. Usually remaining in the effluents after secondary treatment are most of the nutrients—nitrogen, phosphorus, potassium—and 20 to 40 percent of the trace amounts of heavy metals that were originally present. Because of the deteriorating effect that these constituents of secondary-treated effluents can have on water quality when discharged into surface waters, advanced treatment of all domestic and industrial wastewaters became a national goal several years ago. One form of advanced treatment is the application of secondarily treated waters to land.

[5] Information concerning visits to the Utica site can be obtained from C. R. Lee at WES.

WINTER OF '77

Ice on the Ohio

by Martin Pedigo

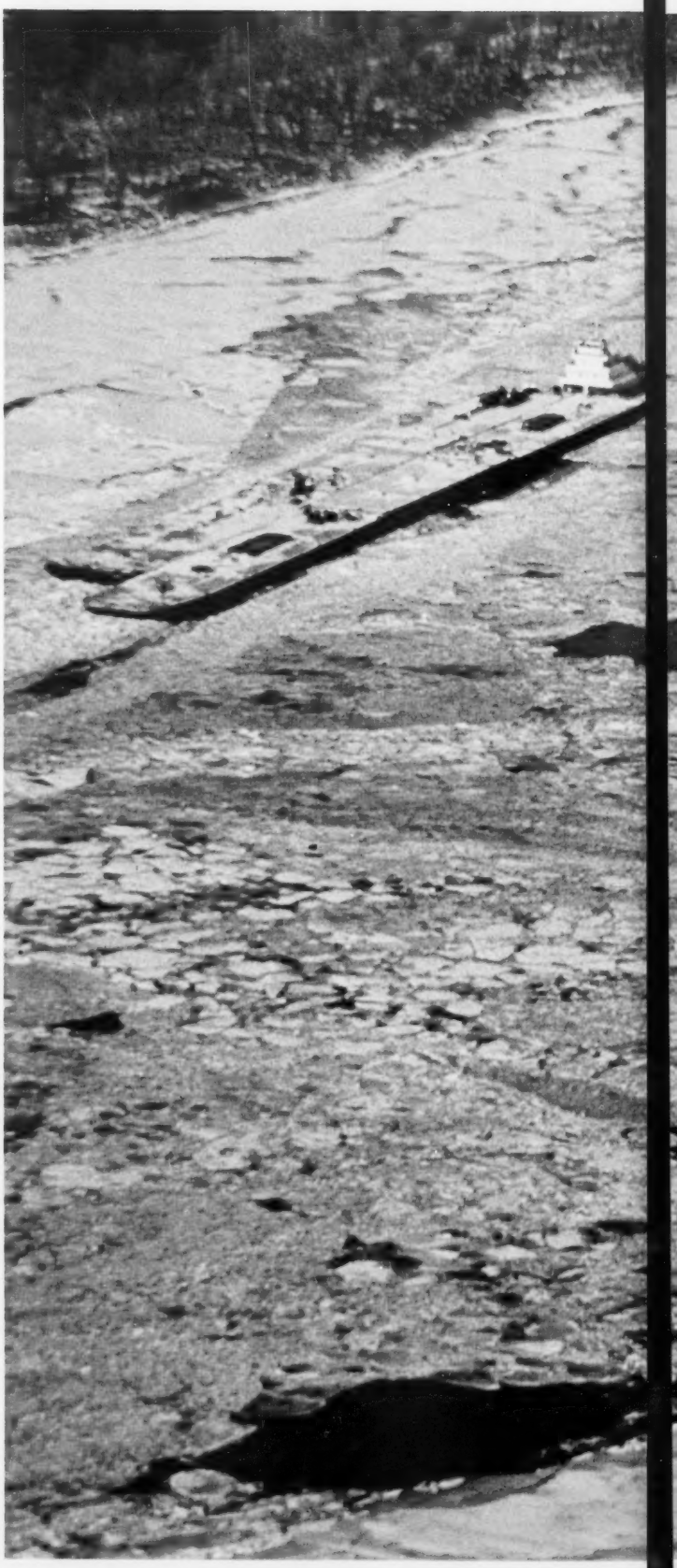
Fifty years from now a lot of senior citizens will be regaling youngsters with: "You don't know what a winter really is—why I remember back in 1977. . . ."

The people who live in and to the northeast of the Ohio River basin will certainly recall that winter. Although heavy snows had hit some cities in the basin in recent years, its largest city, Louisville, had gone more than 5 years without any major snowfall. Then, 3 to 5 inches hit Louisville the night of January 6.

On "Super Bowl" Sunday, January 9, the basin was hit with a crushing winter storm. Nine inches of snow fell on Louisville, with similar amounts reported throughout the central portion of the Ohio basin and more than thirteen inches in the Allegheny River basin to the northeast. Subzero temperatures began to chill the entire area. At Cincinnati, the temperature dropped to minus 24 degrees Fahrenheit on January 17, an all-time record. Within 24 hours the record was broken when the thermometer registered 25 degrees below zero.

Ice began forming on the Ohio River, not just up at Pittsburgh where the Ohio begins but all the way down its 981-mile length. Many persons stopped to think of the river's importance to their lives as waterborne traffic decreased drastically. The Ohio and its navigable tributaries carry some 170 million tons of cargo each year, which is more than half the intercity freight movement in the Ohio basin. Energy-producing coal and petroleum products make up better than 50 percent of this river traffic. It was feared that homes would eventually be without heat as fuel supplies dwindled.

Strangely, the great ice season of 1977 had its beginnings back in the summer of 1976. Rainfall was not as heavy as it should have been. Many parts of the United States, even the world, were having droughts. The first notice of this came in news stories



The weight of this icy mantle covering the wooden wickets at L&D 50 threatened the structure and made it necessary to lower the wickets.

During the unusual subzero temperatures and bitter winds of last winter, maneuver boat crews had to chip off some of built-up ice with axes before they could manually lower the wickets.

about agricultural problems. Stories filtered into the newspapers and news magazines about low water on the Mississippi and Ohio Rivers. River traffic encountered shallow spots that either slowed or stopped the tows and necessitated lighter loads than usual.

Although October's rainfall averaged above normal throughout the basin, the fall season did not bring much relief. By the end of the year, the Ohio River basin's major cities and rural areas were reporting rainfall 10 to 20 percent below normal for the year. This led some to remark that 1977 was the 40th anniversary of the great flood of 1937, but conditions were certainly not right for a repeat of that disaster.

Any elation some may have felt over the unlikeliness of another huge flood gave way to pessimism over low river stages in what should be the rainy season in the basin. Shallow rivers freeze more rapidly because they cool faster and are less turbulent. In addition, the U.S. Army Corps of Engineers was particularly concerned because the old wicket dams (*see box*) on the lower Ohio were still up. Concern centered on the Corps Louisville District since the final 135 miles of the Ohio River, from the Uniontown Locks and Dam near the Illinois-Indiana border down to Cairo, Illinois, are not yet served by modern high-lift dams.

Winters in the lower basin are usually rainy, resulting in a normal flow or an "open river" condition that allows the movable wicket dams to be lowered. Boats can then move over them and through the navigable pass adjacent to the lock. During low flow conditions of this past winter, however, the wickets were raised to create enough depth to carry river traffic. Unfortunately, when the temperatures went low enough to

freeze water flowing over the wooden dams, the wickets were a ready target for the ice.

Worst of all was the danger the wickets presented to the men who had to struggle to lower them before the built-up ice could tear out whole sections of the dams. Raising and lowering the heavy oak wickets—more than 300 of them lined up side by side to form a dam—is done manually by a crew working from a maneuver boat that inches along the face of the dam. These small vessels are equipped with a power winch and a crane; but, in the conditions of last winter, the crews first had to use axes to chip some of the ice away—in bitter winds and subzero temperatures.

Ice did not stop all traffic on the system, but tonnage dwindled to between 15 and 20 percent of normal in late January and early February. Many towing companies simply stopped operating altogether and only towboats with more than 4,000 horsepower were able to plow through. Towboats that did move had tows much smaller than normal and crept along at 1 to 3 miles per hour, much slower than their normal speed of 6 to 8 miles per hour.

While most of the navigation problems were on the lower Ohio, the upper basin also had its difficulties. On the Allegheny and the Monongahela Rivers, Corps personnel were working at all locks and were willing to lock through any vessels that approached. However, the towing industry in effect closed portions of the two rivers which form the Ohio by refusing to buck the heavy ice. Towboat pilots elected not to attempt the Allegheny River above Lock and Dam 2, just outside Pittsburgh, or the Monongahela River above the lock at Morgantown, West Virginia. For awhile, the Coast Guard closed the entire Allegheny to all hazardous cargoes, including petroleum.

When traffic slowed because of the ice, it was bad; but when it stopped, the situation became critical. The Northeast was suffering from such severe cold that fuel supplies had to be sharply reduced or even cut off in many areas to all but residential users. Coal for electric power plants and petroleum products for fuel were the major cargoes loaded on barges stalled at various points on the river, particularly along that part of the Ohio that forms the border between western Kentucky and southeastern Illinois.

Little did anyone know what was in store. By the second week of January the National Weather Service was reporting ice 3 to 8 inches thick that reached from bank to bank on most of the Ohio. On January 11, the Louisville District's Emergency Operations Center went on a 24-hour a day schedule. Constant communications were kept with lockmasters, ice patrol teams looking for ice buildups, and commercial tow crews for their assessment of the situation.

Lockmasters all along the lower Ohio were getting

As the wickets were lowered one by one, water rushed through the widening gap and the navigation pool was lost.

Huge, swiftly moving chunks of ice were a hazard to the men and equipment lowering the wickets.

assistance from commercial towboats using the turbulence created by their propellers to wash ice off the wickets at the old dams. The towboats were also breaking up ice jams at many points along the river, allowing smaller and less powerful boats to keep moving. Even where the ice stretched from bank to bank, the channels were kept open by the tows breaking up the ice as they went through.

On January 16, towboat pilots started reporting that an ice jam in a sharp bend of the Ohio, near Carrsville, Kentucky between Locks 50 and 51, was slowing them to the point where they might have to stop. Traffic on the river was soon reduced to about one-third of normal with only the more powerful towboats continuing to operate. On January 18, the Carrsville ice jam effectively closed the river, meaning that petroleum shipments from the Gulf area coming upstream and coal shipments heading downstream for the Tennessee Valley Authority plants were stymied.

Ice conditions became so potentially dangerous that lock personnel lowered the wickets at all of the old dams on the lower river before an ice buildup could make that impossible. This removed the wickets from the threat of huge chunks of floating ice that could have been created in a sudden thaw of the river.

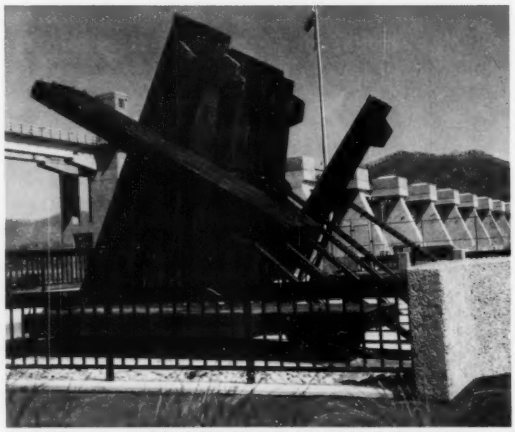
Crews from the locks who had to get out on the river to lower the wickets displayed their usual dedication to duty in performing obviously dangerous work. If they had not been lowered, the dams could have been damaged so severely that they might have remained out of commission for weeks, months or even years.

Lowering the wickets, however, created another problem. There was not enough water flowing to keep an open river. The pools started dropping and at some

The first Federal improvements for navigation on the Ohio River came in 1824 with the removal of snags and sandbars. These measures were effective, but they were only temporary—new sandbars would appear after every flood. They also provided no relief against low water, which stopped navigation almost every year. The construction of a dam with a stable pool and a lock bypassing the dam would have ended problems caused by low water, but the shippers who needed the full width of the river for maneuvering were opposed to a dam.

A compromise solution was a movable dam that could be raised in times of low water to create a pool and lowered when the flow was adequate for navigation. The dams finally built had a series of Chanoine wickets, invented by Frenchman Jacques Chanoine, extending across the river. A system of 50 movable dams was built on the Ohio River between 1879 and 1929, making the Ohio navigable for its entire length at all times.

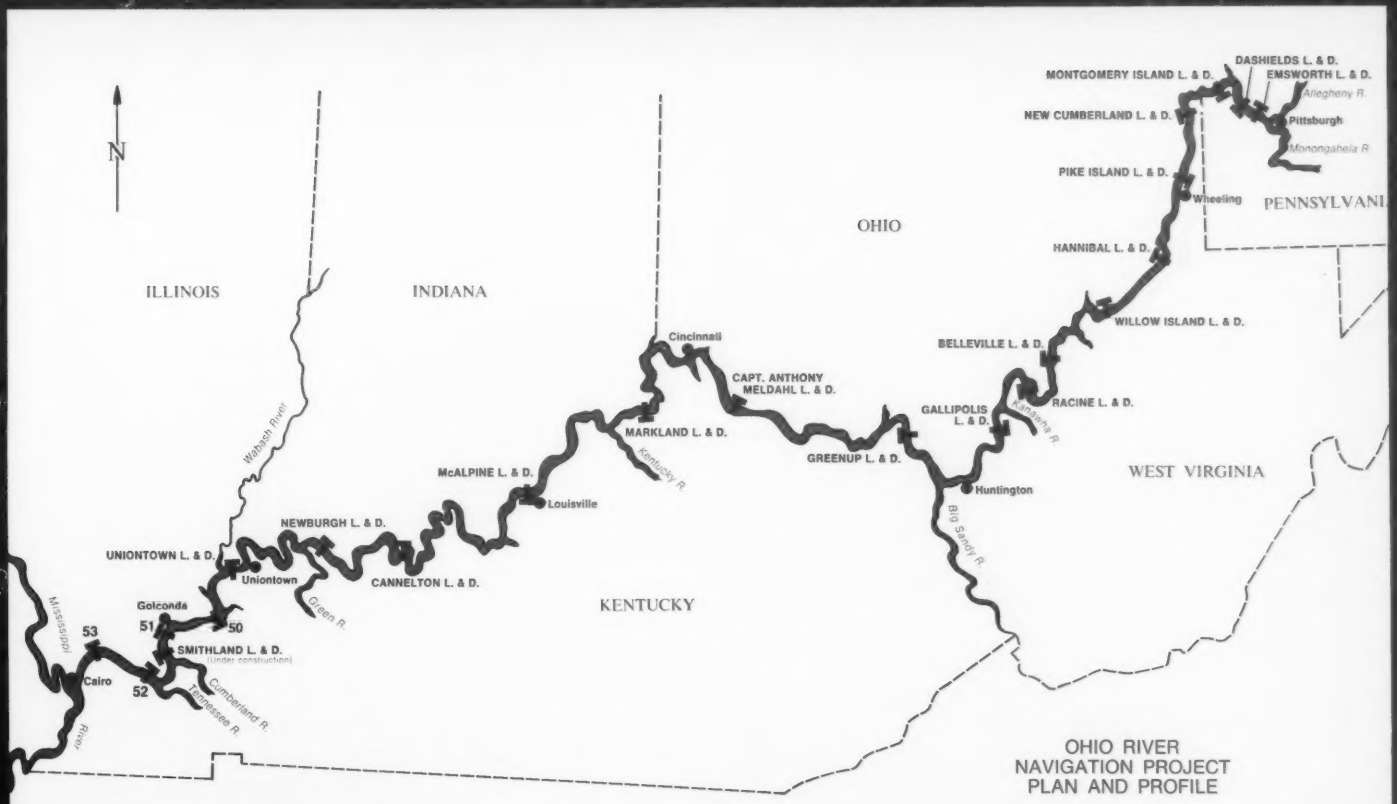
Each dam actually consists of a row of 300 or more little dams, individually hinged to a foundation on the river bottom. The wickets are constructed of heavy timber about 4 feet wide and up to 20 feet long. Raising or lowering the wickets is done by a crew on a maneuver boat that moves along the upstream face of the dam. A bar is connected to the back of each wicket with the free end riding in a groove in the foundation. To raise them, a grapple hooks a wicket and pulls it from the bed of the river. The bar slides up the groove to a niche, where it catches and supports the wicket upright against the flow of the river.



A portion of an old wicket dam is displayed alongside the modern dam that replaced it on the Ohio River.

The niche and groove are so designed that pulling the bar past the niche allows the bar to release and slide back down the groove, lowering the wicket again to the river bottom.

The advent of the more powerful diesel towboat after World War II greatly increased the size of the tows operating on the Ohio River. The tows were longer than the 600-foot locks and had to be broken into two segments for locking, more than doubling the time necessary for a lockage. A modernization program was begun on the Ohio in the 1950s to replace the old dams and the undersized locks with higher dams and longer locks, making the locking operation faster and less frequent. By 1977, all but the lowest four wicket dams had been replaced. It was at these old wooden dams that ice during the winter of '77 threatened structural damage.



shallow spots there was less than 5 feet of water in the normal 9-foot channel. Traffic was stopped by both the ice jam and low water.

After nearly 9 days of traffic stoppage, six commercial towboats began trying to break the ice jam at Carrsville. It took them about 24 hours, but on January 27 the tows reported that they had opened a 300-foot-wide channel through the ice jam that extended over a 4-mile reach of the river.

Traffic, of course, was still stopped by the shallow spots in the channel. Later that day the decision was made to try to raise the wickets in an effort to get traffic moving again. The danger to the dams was taken into account, but the Ohio River Division Engineer said the critical nature of the fuel shortages in the Northeast made it imperative to try this maneuver.

Raising the wickets was probably more dangerous than lowering them had been. The weather had not improved, and occasional chunks of ice crossing the open areas of the dams were large and potentially lethal. It took 3 days to get all of the dams completely raised. It was February 1 before the river had risen enough to start traffic moving again—almost 17 days since the ice jam had closed the waterway. The district gave first priority on locking to tows carrying coal or fuel oil.

Though traffic was moving again, the ice still covering most of the river meant that travel time was at least

Many operators simply stopped during the 6 weeks in January and February when the ice was at its worst. This area behind McAlpine Locks and Dam at Louisville was a safe refuge.

The Ohio River begins at Pittsburgh with the merger of the Allegheny and Monongahela Rivers. The ice choked Allegheny was closed to traffic a few miles above this point.

Only the most powerful towboats were able to keep moving. Even they could push only a fraction of the normal number of barges at speeds well below normal.

tripled. Barges loaded with coal were being put on the front end of tows to protect the petroleum barges' skin from being ruptured by ice.

Then on February 2, floating ice ripped a hydraulic line out at Lock 51, closing it to traffic. The next morning repairs were completed and the Ohio River was open to traffic—if they could get through the ice. All locks were operating.

On February 7—after only 4 days of traffic—another accident closed Lock and Dam 50. The Motor Vessel *Frank Stegbauer* was helping out by washing ice off the wickets at 50, when somehow the towboat was caught in the current and washed through the dam, knocking at least a dozen wickets to the river bottom. There were no injuries to crewmen, but the resultant "hole" in the dam meant the river would start going down again. Within a few hours traffic was stopped above Lock 50 as shallow spots of less than 7 feet in the channel were reported at two sandbars.

Slowly moderating temperatures crept into the valley the second week of February. By the time repairs were completed at Dam 50, there was enough flow in the river to lower all four wicket dams. The entire Ohio was now open river. Naturally, in the next few days there was a traffic jam of tows waiting to be locked through at the facilities upstream, but on February 16 the Louisville District was able to close its Emergency Operations Center. Although some melting ice still floated atop it, the river was well on its way back to normal. Traffic was moving at almost average speeds and its volume, which totals more than 140 million tons of freight a year, was also about normal.

During the winter of 1977, many plants had to close and many persons were out of work. If the river had been open the entire time, certainly many of these lost jobs and plant closings would not have been necessary. At this time, there is no way to assess the total dollar cost of 1977's Ohio River ice jam, but there is no doubt that it cost many millions. Its toll in human suffering is often intangible but is still very real.

So when we get nostalgic 50 years from now, it may impress others to talk about the hardships of the winter of '77. Those of us who were involved will also remember all the efforts of the many who helped to break up the ice, keep the channel open and the lock facilities working to get the fuel-laden barges through. We will also recall just how much we missed being able to depend on that river that we had taken so much for granted. □

FLOOD INSURANCE
A Growth Story

by J. Robert Hunter

Fear of spring flooding due to the unusual weather conditions of the past winter has prompted a record number of persons to purchase insurance available under the National Flood Insurance Program. The following article examines the progress that has been made with the program since an earlier article on this subject, "The Turning Point," was published in Vol. 6, No. 2 of Water Spectrum.

This hospital in Wellesville, N.Y., partially collapsed into the Genessee River when floods caused by Tropical Storm Agnes swept through town. It is estimated that $1.5 billion worth of urban property is lost in floods each year.

Builders in identified flood-prone areas are now required to follow safer construction standards. As new structures replace the old, flood damages should be reduced.

Most Americans, fortunately, experience floods only vicariously through media coverage of major disasters. For 10 percent of the Nation's population, however, floods are a perennial threat to life and property. While many of us will never directly experience the destructive force of floodwaters in our homes, every American taxpayer pays a price, through costly disaster aid, for uninsured flood damages and unsafe construction on the flood plains.

While precise statistics are unavailable for the total cost to the taxpayer for flood disasters, the Government has found that 90 percent of all Presidentially declared natural disasters have been flood-related. In assessing the national flood problem, the Water Resources Council now estimates that over $1.5 billion in property losses occur in urbanized areas each year. Today, about 20,000 communities across the Nation have flood-prone areas of varying degrees. Yet these statistics are dwarfed by the toll in human life and suffering floods have exacted. Over 10,000 Americans have, in this century alone, lost their lives in flood disasters. And the cost of human suffering is incalculable.

National policy initiatives to reduce flood losses have been unsparing as one component in this national effort. The National Flood Insurance Program has made monumental strides toward the national goal of reducing the mounting toll of life and property from floods as well as the burden of disaster relief borne by all taxpayers. The flood insurance program provides low-cost, federally subsidized flood insurance—almost prohibitive to buy privately because of its high cost—in communities that enforce construction safeguards to reduce or eliminate flood damage to new development in flood plains.

Today, more than 15,300 flood-prone communities are administering various construction safeguards under the program. In return, the program's low-cost insurance has become available for purchase by 97.5 percent of the insurable owners of the 6.4 million properties in the Nation's flood plains. Today, about one million flood insurance policies are in force with coverage against flood losses totalling $30 million. In bread-and-butter terms, this means that 16 percent of insurable property in the Nation that is exposed to severe flood risk is covered by insurance against flood loss. These statistics become meaningful when one realizes that 9 years ago, flood insurance coverage was virtually non-existent. Americans owning property in a flood plain had no practical method of protecting themselves from economic losses due to floods.

Today, the flood insurance program is reaching its maturity. To understand this growth, it is appropriate to recount how the program's current success emerges

Mr. Hunter has been Acting Federal Insurance Administrator since December 1974.

In identified flood-prone areas such as this one in Wilkes- Barre, Penn., construction, renovation or acquisition loans cannot be obtained from a Federally assisted lender until flood insurance has been purchased.

in sharp relief against the limitations and growing pains of the program during its formative years.

A Beginning

In 1968, Congress created the authority for a National Flood Insurance Program. For the first time, flood insurance coverage was made available to the public by means of Federal subsidies. The availability of the insurance in a given area, however, hinged on the local government's administration of construction safeguards for new development in flood plains. The program at this stage was ineffective in covering the Nation's flood risks. Participation in the program and the purchase of flood insurance were purely voluntary. There simply were no strong incentives for communities to enroll in the program or for individuals to purchase the insurance, once it had become available.

From 1968 to 1973, the program's *optional approach* to the purchase of flood insurance and community commitment to flood plain management proved to be a major defect.

For instance, in 1972, the so-called "year of the floods," thousands of flood victims were found to be without insurance protection to recover their losses. In June, a normally placid creek in Rapid City, South Dakota became swollen with storm water, washed out a local dam and tore through the city's business district. In that disaster, 236 people lost their lives. Federal disaster assistance totalled $100 million, yet only 29 flood insurance policies were in force to help defray the cost of the disaster.

That same summer, Tropical Storm Agnes cost the Nation $3.1 billion in property losses. Only two flood insurance policies were in force in Wilkes-Barre, Pennsylvania, one of the most severely hit communities. In the entire Commonwealth of Pennsylvania, only 818 flood policies were in effect. Also in 1972, 15 persons drowned when flood waters from the Guadalupe River at New Braunfels, Texas, rose 20 feet above previous recorded flood levels. Only four flood insurance policies were in force.

Flood Disaster Protection Act of 1973

After the disastrous year of the floods, Congress recognized that a reduction in uncompensated flood losses and increased public safety in the flood plains could be achieved only with stronger incentives for communities to enroll in the flood insurance program. Thus, Congress enacted the Flood Disaster Protection Act of 1973 which:

- Requires that the Department of Housing and Urban Development identify all known flood-prone areas nationwide;
- Requires the purchase of flood insurance as a condition for Federal or federally backed loans

for construction or acquisition in identified flood-prone areas;

- Prohibits making federally connected loans in the identified flood hazard areas of communities that fail to join the program by prescribed dates.

The incentives written into the 1973 legislation resulted in dramatic increases in membership. From the date the 1973 law was passed to the initial 6-month deadline for enrollment, the number of communities participating in the program increased by more than four-fold: from 2,856 to 9,625—with the number of policies in effect nearly doubling to 539,888 and totalling $13.7 billion.

The program's success under the Flood Disaster Protection Act of 1973, with its requirements for flood insurance and lending prohibitions in flood-prone areas of non-participating communities, can also be measured by the increased enrollment in those communities and States that were devastated in the summer of 1972.

Today, in Rapid City, South Dakota, even after floodway clearance efforts have significantly reduced the risks, 436 flood insurance policies are in force with coverage against losses totalling over $12 million. In Wilkes-Barre, Pennsylvania, more than 4,300 policies are now in force, with flood coverage amounting to $132 million. Flood insurance policies in effect in New Braunfels, Texas, now number 255 with insurance against flood loss totalling over $6.6 million. In the Commonwealth of Pennsylvania, over 100,000 policies are in force that compensate for flood losses on property valued at $2 billion.

About 80 percent of the Nation's identified flood-prone communities are enrolled in the program today. With individual policies exceeding one million and coverage against flood loss totalling $30 billion, the program has reached a well-defined level of success. Thus, its insurance requirements and incentives for community enrollment are the principal reasons for its successful growth.

Eloise Poses Test

Hurricane Eloise in September of 1975 provided the first genuine "test case" of the program's effectiveness under the Flood Disaster Protection Act of 1973. Eloise traced the path set by Tropical Storm Agnes—up the eastern seaboard, through the Susquehanna River basin, and on into New England, devastating almost everything in its wake. While less than 1 percent of the insurable flood losses were covered by insurance in the Agnes disaster of 1972, more than 25 percent of the 1975 flood losses were covered by insurance. Significantly, insurance claims payments increased from $5 million for the victims of Agnes in 1972 to about $50 million for victims of Eloise. The

Communities such as Ellicott City, Md., shown here after visit from Hurricane Eloise, must enroll in the National Flood Insurance Program before residents can puchase its low-cost flood insurance.

lesson learned from the Eloise disaster is that the contractual right of property owners to indemnification for flood loss is gradually replacing the enormous annual Federal cost of disaster relief—precisely as Congress had intended in 1968 when it established the National Flood Insurance Program.

The Eloise experience helped to change public opinion at a time when the flood insurance program, the insurance requirements, and the strong incentives for community enrollment were all received less than enthusiastically by a number of communities and by various elements of the public and private sectors. Adding these requirements and incentives to the voluntary program had achieved the desired increase in participation, but these measures also created problems.

In the early phases of operation under the Flood Disaster Protection Act of 1973, much skepticism existed concerning the program's underlying intent and the ability of one Federal agency to provide technical and regulatory direction for every flood-prone community in the Nation. A backlash developed over the program's requirements. The situation was not helped by the publication of some initial flood maps that, poor in quality, carried out the identification function under the 1973 Act. Also, since the program's construction standards required community recognition of the flood hazard—in many cases for the first time—many local governments were confused over their exact responsibilities in this national effort.

Today, there is every indication that practical experience with the program's requirements, coupled with specific guidance from the Department of Housing and Urban Development (HUD), has resulted in a rethink-

In 1972, "the year of the floods," participation in the National Flood Insurance Program was still voluntary. Only 29 flood insurance policies were in force in Rapid City, S. Dak., when storm-swollen creek waters overtopped a small dam and ravaged developments on local flood plains.

ing by everyone concerned with the decisions relating to flood plain occupancy and development. The program's underlying logic and potential benefits are now more readily understood. One HUD report on the program's effectiveness indicated that coastal communities have amended existing local ordinances to comply with the standards of the flood insurance program. Significantly, there is evidence that coastal communities are enforcing safer flood plain standards to reduce future losses. Builders are following these standards, and lenders are in full compliance with flood insurance requirements.

1975 Amendments

By 1975, the strengthened program was growing rapidly and becoming more effective. One remaining problem was complex enough, however, to require additional legislative action. Thus, the Housing and Urban Affairs subcommittee of the Senate Committee on Banking, Housing and Urban Affairs held emergency hearings in June 1975 on the flood insurance program to address the concerns of members of Congress, certain community officials, and representatives of the lending community. The discussions focused on the imminent statutory deadline of July 1, 1975, when the lending prohibitions of the 1973 Act were to take effect in the identified flood-prone areas of non-participating communities.

The observable growth in community participation at that time helped to allay major concerns over the nationwide effects of the lending prohibitions that ap-

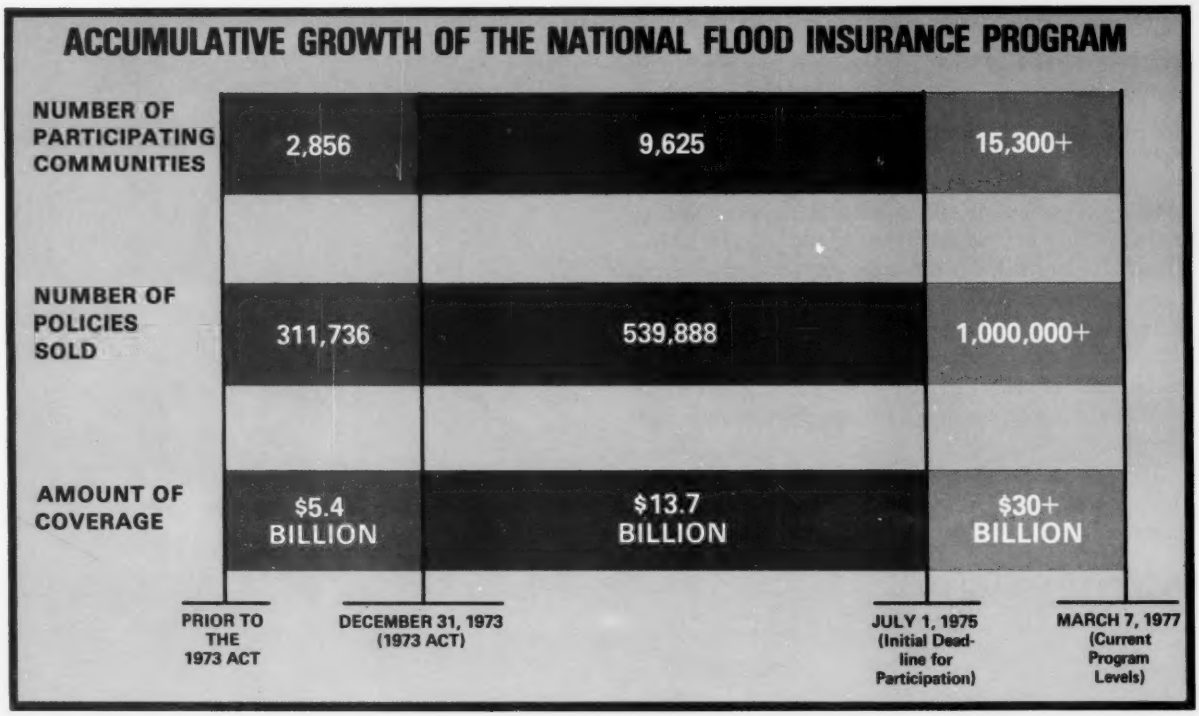
plied to identified, non-participating communities. Genuine Congressional concern persisted, however, over the individual homeowner's inability to sell his home to a willing buyer, otherwise eligible for conventional mortgage-loan financing, because of the community's failure to qualify for the flood insurance program.

The emergency hearings resulted in an amendment to the 1973 Act and culminated in the signing of the Emergency Housing Act on July 2, 1975. Section 303 permits conventional mortgage-loan financing, made prior to January 1, 1976, for acquisition of a "previously occupied residential dwelling" in the identified special flood hazard areas of a community that failed to qualify for the program by its prescribed date (July 1, 1975, or one year from identification, whichever is later). The exemption enabled homeowners to sell for a limited period of time existing housing—located in flood-prone areas of non-participating communities—to homebuyers who could obtain conventional mortgage-loan financing. With that enactment, Congress redressed the potential hardship faced by certain property owners who would otherwise have been penalized by their communities' inaction in adopting minimum flood plain management measures.

Congress, in a joint resolution on December 31, 1975, extended this exemption period for conventional mortgage financing of previously occupied dwellings in the identified flood-prone areas of non-participating communities through March 1, 1976. A permanent exemption of the lending prohibitions for conventional mortgage-loan financing for such existing dwellings became law with passage of the Housing Authorization Act of 1976. Section 14(a) of that law provides the following exemptions to the lending prohibitions for conventional mortgage-loan financing of the 1973 Act:

- Any loan made to finance the acquisition of a residential dwelling occupied as a residence prior to March 1, 1976, or one year following the identification of the area where the dwelling is located as a special flood hazard area, whichever is later;
- Any loan, which does not exceed $100,000 to finance the acquisition of a building or structure completed and occupied by a small business concern, as defined by the Secretary, prior to January 1, 1976;
- Any loan or loans, which in the aggregate do not exceed $5,000, to finance improvements to or rehabilitation of a building or structure occupied as a residence prior to January 1, 1976;
- Or any loan or loans, which in the aggregate do not exceed $25,000, to finance non-residential additions or improvements to be used solely for agricultural purposes on a farm.

In effect, these amendments soften the full bite of the 1973 Act's penalties for non-compliance, as the law was originally passed. Now banks and other lending institutions have legal authority to approve conventional financing for various existing properties in the identified hazard areas of non-participating communities.



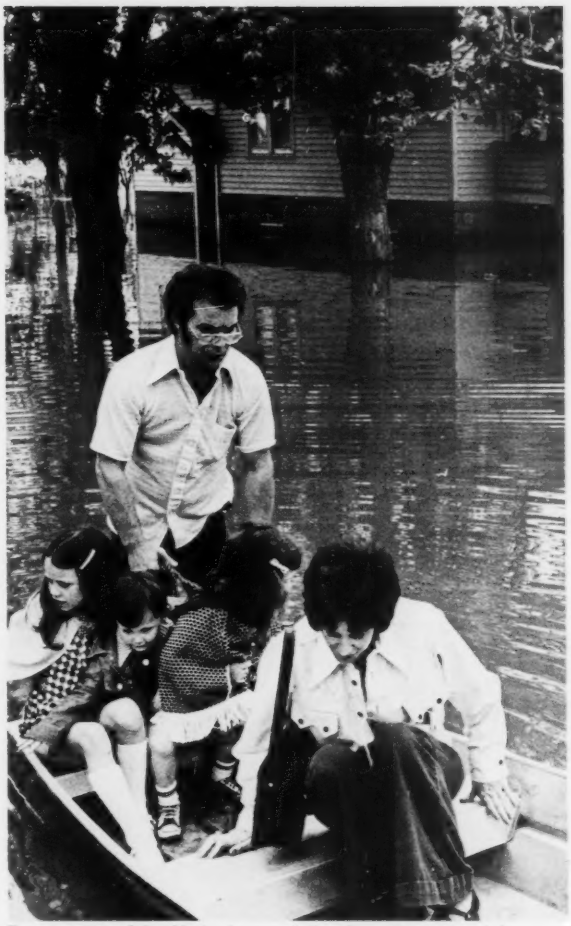
While the flood insurance program is not the panacea for correcting all of the Nation's flood problems, it has taken great strides toward that overall goal. Significant reductions in disaster relief will continue to be realized, through safer flood plain management and insurance coverage of buildings and contents in the Nation's flood plains.

By the year 2000, it is estimated that *without* the National Flood Insurance Program, flood damage to items insurable under the program would have reached $3.2 billion. Of that total, Federal tax dollars would have provided $1.3 billion in disaster aid with the remainder uncompensated. *With* the program, however, it is estimated that flood losses will reach only $1.3 billion annually in the year 2000, requiring $300 million in taxpayer costs. The remainder, $1.1 billion, would be covered by insurance premiums. An additional $1 hundred million is needed for research and program administration.

This goal of the National Flood Insurance Program can and will be achieved. As the Nation's stock of housing in the flood plains is replaced by degrees with new structures designed to withstand flood damage through proper elevation and floodproofing, the extent of flood damage will be proportionately reduced. In turn, the national body of taxpayers—90 percent of whom live in non-flood prone areas—will have to provide fewer dollars for disaster relief in the aftermath of major flooding.

In short, the program's careful balance between insurance against loss and loss prevention through flood plain management will, in time, pay huge dividends. It will reduce not only the burden of disaster relief borne by all taxpayers, but, more importantly, the suffering of future flood victims.

The National Flood Insurance Program has, then, weathered some uncertainty during its formative years. Today, the program is sound and is providing the kind of protection to communities and property owners that Congress intended.□



Ten percent of the Nation's population face the perennial threat of floods.

LIMITS OF COVERAGE AND SUBSIDIZED RATES

	Structure		Contents**	
Type of Structure	Coverage	Rates per $100 of coverage	Coverage (per unit)	Rates per $100 of coverage
Single family residential	$ 35,000	$0.25	$ 10,000	$0.35
All other residential	$100,000	$0.25	$ 10,000	$0.35
All nonresidential*	$100,000	$0.40	$100,000	$0.75

**Includes hotels and motels with normal occupancy of less than 6 months.*

***Tenants of each unit of both residential and nonresidential buildings may purchase contents coverage independent of structural coverage.*

Events, Deeds & Deliberations

Endless Alert

The following account is taken from the weekly report of Resident Engineer Curtis E. Weddle, Jr. of the Fort Smith to Port of Catoosa Section of the McClellan-Kerr Arkansas River Navigation System.

"Wishing for words of wisdom and comfort tonight—wisdom enough to be able to keep people from getting into situations that cause them harm and comfort for those who are left because of tragedy.

"Another drowning, below the Robert S. Kerr powerhouse, and, but for a lot of luck, we might have had more. The victim was dipping shad for bait when evidently the currents caught his net and pulled him into the icy cold waters. Another fellow jumped in after him and nearly lost his life in the rescue attempt. Fortunately, the powerhouse people were coming in from Webbers (Webbers Falls Lock and Dam) or there might not have been as quick a shut-down of the one unit generating as the powerhouse operator was able to make. This enabled our people to throw in a ring buoy which was grabbed and the rescuer was pulled to safety.

"I've watched the turbulence below our various dams for years, but was surprised to see just how long it continues—even when the power is completely shut off. Swift currents were still evident over 30 minutes after the shut-down!

"This area is one of the most favored fishing spots on the whole system, constantly and heavily used. It is extremely dangerous if all safety rules are not observed and if our users don't exercise constant vigilance and common sense. I wish everyone who fishes there were able to see our film 'Not By A Damsite.' It shows what can and did happen there yesterday.

"We discussed several things that might help prevent any further tragedies while the recovery operations were being staffed-up and equipment—lights, boats, drags—was being brought in and readied. Putting ring buoys and life-lines along the shore would have prevented this drowning; a fishing line almost worked. If they were provided, they would probably either be stolen or thrown into the river by that few in number who always, always seem to get into the picture and spoil it for the rest. We should try something anyway. There's always the hope and chance it might do some good."

It's Cleaner Than You Think

The Environmental Protection Agency has found that pesticide levels in the Nation's drinking water are very small compared with other sources—residues on food for instance. In its recently completed national survey, 350 water supplies were analyzed for the presence of aldrin, dieldrin and DDT. Where detected at all, the substances were found in extremely small concentrations.

While it has little data on technology to treat or remove the chemicals now present, the agency expects pesticide levels in the general environment and drinking water to decline naturally because of bans now in effect.

Earthquake Prediction Group Established

An Earthquake Prediction Council, the only Federal body of its kind in the United States, has been established by the U.S. Geological Survey of the Department of the Interior. Council members are all with the Survey's Office of Earthquake Studies at Menlo Park, California. Although earthquake forecasts are not yet reliable, this new group was formed because recent research indicates that such a capability will be possible in the near future. The U.S. Geological Survey Director is responsible for giving warning of geologic catastrophies, where possible, as a result of the Disaster Relief Act of 1974.

Not only will the five-member council review the prediction evidence of U.S. Geological Survey scientists, it will also look at predictions of non-Survey scientists at the request of a State or Federal official or when the Survey deems a review to be appropriate.

The council will focus its efforts on potentially destructive earthquakes which generally are those of magnitude 5.5 or greater on the Richter Scale. However, data for smaller earthquakes will also be reviewed to establish a "track record" for prediction techniques.

A prediction is a statement that gives the time, location and probable magnitude of the occurrence as well as the nature and severity of geologic hazards associated with the predicted earthquake.

Tired Wave Breakers

An inexpensive method for constructing portable breakwaters has been developed by a group of scientists at the University of Rhode Island. Funded by private industry and the Federal government, the group has experimented for the past 2 years with recycling old, discarded tires into new structures to protect shorelines and small boat marinas from wave erosion.

In the research team's favored design, 18 tires are stood upright and strapped together with stainless steel cable into a diamond-shaped pattern. Each 18-tire unit makes a small raft that can be assembled on shore in about 10 minutes. These units are then pushed into the water, where they are strapped together, and moored to the bottom to form a breakwater. The maximum size used has been 500 feet long by 22 feet wide, which makes a breakwater large enough to reduce a 3-foot wave to less than a foot.

An important advantage of these scrap-tire rafts is their flexibility. They can be arranged into the configuration most suitable for each site and can be moved in response to changing conditions.

These breakwaters provide other benefits, too. After a few months barnacles and seaweed begin growing on the tires, supplying food for small fish that draw larger fish that, in turn, attract sport fishermen.

The scrap-tire rafts are not only less expensive than conventional fixed breakwaters; no shortage of their primary construction material is foreseen in the near future. Discarded tires in the United States are accumulating at an estimated rate exceeding 200 million a year.

Army Awards Medal

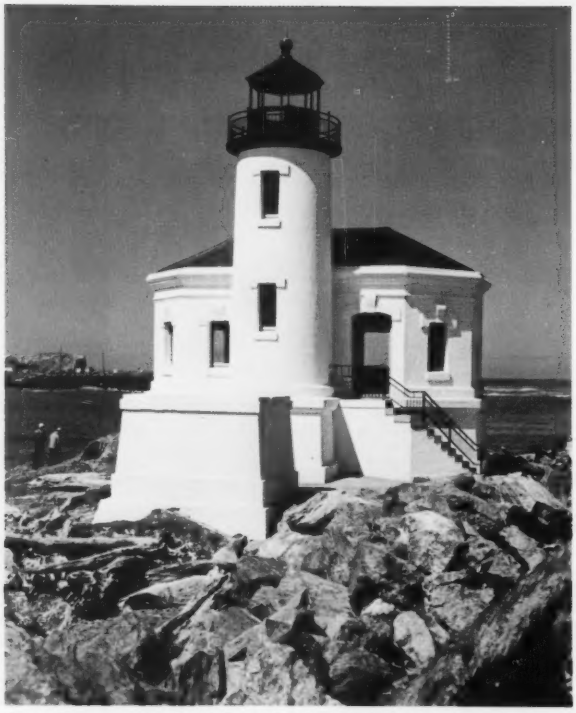
George W. Griebenow, Chairman of the Upper Mississippi River Basin Commission and author of the GREAT article published in our preceding issue, has been awarded the Department of the Army's Outstanding Civilian Service Medal by the Chief of Engineers. Griebenow was recognized for his contribution to water resource planning in the upper Mississippi region and for his support of the Great River Study.

Interest Rate Raised

The Water Resources Council has announced that the interest rate to be used by Federal agencies to formulate and evaluate plans for water and related land resources has been raised to 6⅜ percent (from 6⅛ percent) for the period October 1, 1976 through September 30, 1977. This new interest rate is to be used for the purpose of discounting future benefits and computing costs, or otherwise converting benefits and costs to a common time basis.

"Where To Find It"

A new guidebook on technology assessment is now available for sale. Designed for the novice in the field as well as the more sophisticated individual, this publication, entitled *Technology Assessment: State-Of-The Field,* contains 155 key works published since 1969 on application and methodologies of technology assessments. This new digest, edited by Dr. Herbert Fox, chairman of the Engineers Joint Council Technology Assessment Panel, contains information on actual assessments in such areas as energy, materials research, education, technology transfer and economics. Some of the performing organizations listed in the volume are Federal and State governments, universities, engineering societies and research organizations. The book may be obtained by writing to the Engineers Joint Council at 345 East 47th Street, New York, New York 10017 or by phoning the Publications Department at (212) 644-7840.



Jurors' comments about Coquille River lighthouse: "The saving and careful restoration of this beautifully sited lighthouse is an act of real significance and sensitivity . . . recognizing the extraordinary vigor and endless inventiveness of these 19th century builders."

Pursuit of Excellence

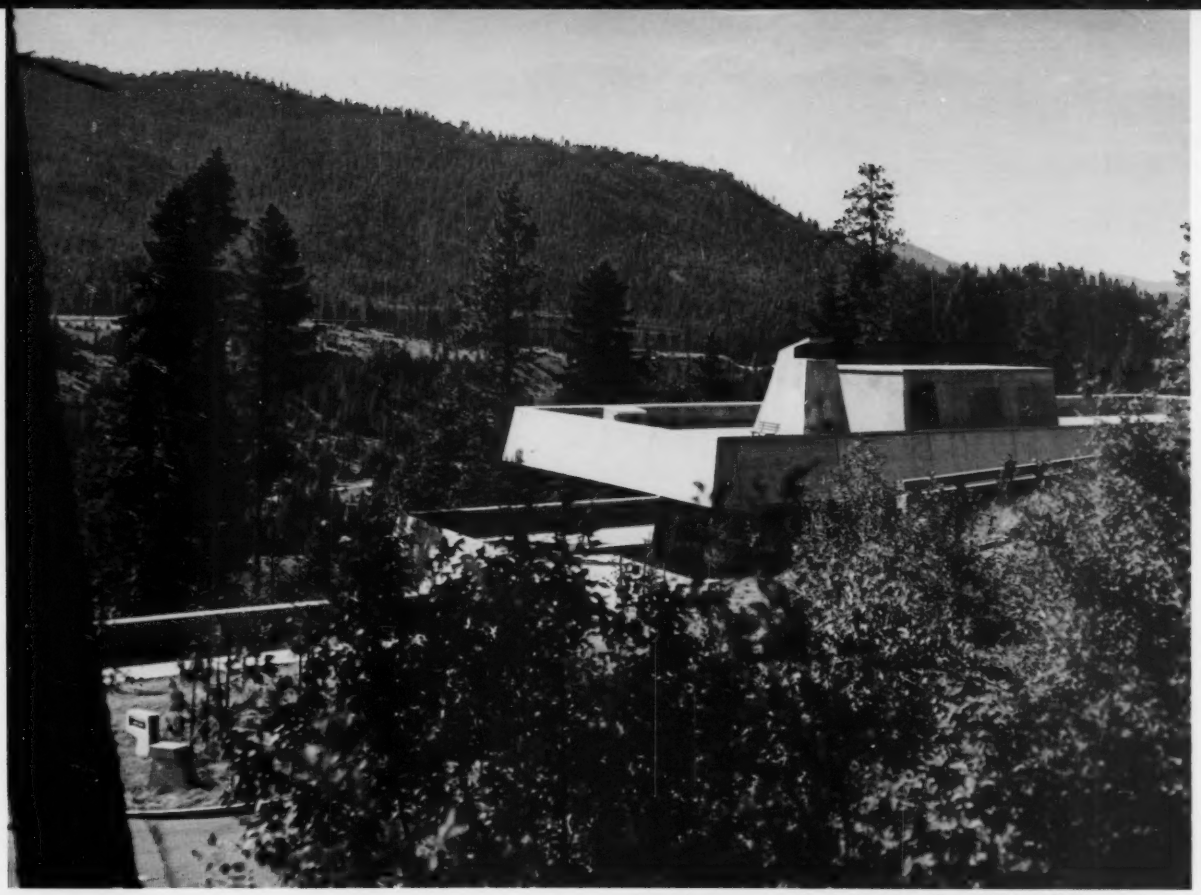
The projects displayed here were among the variety of 86 entries submitted for the Corps' 1976 Distinguished Design Awards Program. These projects represent those nominated by the Corps division and district offices and their consulting firms for the three categories of architecture, landscape architecture and engineering.

The 10th such competition sponsored by the Chief of Engineers, its purpose is to recognize outstanding design of structures and area developments and to stimulate excellence in future projects. Award winners were chosen by a panel of nationally recognized professionals who considered each design's excellence—through function, economy and creativity—in meeting the challenges confronting every project. Equally important were the individual design's aesthetic quality and the extent to which the finished project harmonized with its environment.

An award of merit in architecture, for example, went to the Portland District for a work of historical preservation on an 1896 lighthouse. The panel believed that not only new designs should be honored but also older designs worthy of preservation. Restoration by the district of the Coquille River lighthouse near Bandon, Oregon included repair of the roof, windows and stairways, concrete work, minor landscaping and painting.

The Seth Myers Nature Trail at Shenango Lake near Sharon, Pennsylvania was cited in the landscape architecture category for its carefully planned layout and unobtrusive structures. This area development, designed by the Pittsburgh District, was judged successful in achieving the overall objective, which was to create an

Seth Myers Nature Trail received honorable mention for its carefully planned wanderings and simple, rustic structures. The trail blends well with the environment and gives security to the casual visitor without offending the aesthetics of the ardent environmentalist.



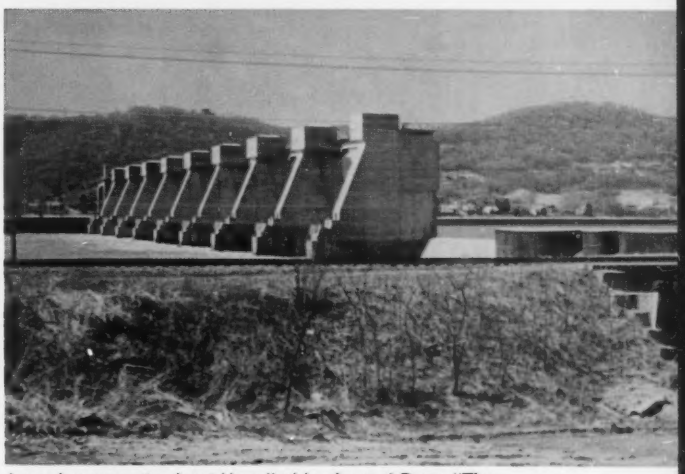
Jurors' comments about the Libby Dam Visitors Center and Orientation Area: "Entire project has a good sense of scale. . . . The use of natural materials, rocks, vegetation and grass lend a natural look to the site development."

appropriate atmosphere for enhancing the education of hikers using the trail.

An award of merit in the engineering category was given for the Hannibal Locks and Dam structure on the Ohio River near Hannibal, Ohio. Also designed by the Pittsburgh District, this structure was commended for the extremely handsome, yet simple execution of a large project with a strength and character appropriate to the scale of its setting.

The Visitors Center at Libby Dam on the Kootenai River near Libby, Montana was a double winner, receiving both architecture and landscape architecture awards. Designed by Thiry Architects, Inc. of Seattle, Washington and supervised by the Seattle District, the entire project was commended by the panel of jurors for its good sense of scale—strong, dynamic buildings in proportion to the nearby mountains and related dam structure.

These were but a few of the award winners. The entries ranged from post offices to hospitals, from office buildings to airline terminals and railroad bridges. Those shown here were selected for their relationship to projects of significance to water resources.



Jurors' comments about Hannibal Locks and Dam: "The project has an economical nature . . . while possessing an aesthetic economy in its use of strong spartan forms."

New Water Weed Guide

A recently published, fully illustrated manual identifies, in color, the most common aquatic nuisance plants and recommends methods and equipment for their control. Copies of the 64-page guide, entitled *How to Identify and Control Water Weeds and Algae,* can be obtained from Applied Biochemists, Inc., P.O. Box 25, Mequon, Wisconsin 53092.

Flood Fighter Honored

The highest honorary award given to Army civilian employees has been presented to James D. Ruyak, the chief of construction for the Army Corps of Engineers, St. Paul District. General Frederick J. Kroesen, commander of the U.S. Army Forces Command, presented the Exceptional Civilian Service Award gold medal to Ruyak for his role in leading the successful fight that averted major flooding in Minot, North Dakota in April 1976.

Industrial Wastewater Control Course

A 2-day engineering course, designed for engineers and others responsible for industrial wastewater control, will be offered by the Cornell University College of Engineering on June 13-14, 1977. Further information can be obtained from Professor R. H. Lance, Associate Dean, College of Engineering, Carpenter Hall, Cornell University, Ithaca, New York 14853.

Coming Events

19th Annual Public Water Supply Engineers Conference at Champaign, Ill., April 5-7.

Ducks Unlimited National Convention at San Francisco, Calif., April 19-23.

1977 National Conference on Treatment and Disposal of Industrial Wastewaters and Residues at Houston, Tex., April 26-28.

Game Conservation International Conference at San Antonio, Tex., May 8-13.

International Conference of the Society of American Value Engineers at Detroit, Mich., May 23-25.

1977 National Conference On Water at St. Louis, Mo., May 23-25.

National Wetland Protection Symposium, sponsored by the Environmental Law Institute and U.S. Fish & Wildlife Service, at Reston, Va., June 6-8.

Outdoor Writers National Conference at Macon, Ga., June 18-24.

Society For International Development Growth Conference at Houston, Tex., October 2-4.

50th Annual Conference of the Water Pollution Control Federation at Philadelphia, Pa., October 2-7.

4th Annual Symposium on Coastal Sediments and Structures Related to Shore Protection and Inlet Stabilization at Charleston, S.C., November 1-5.

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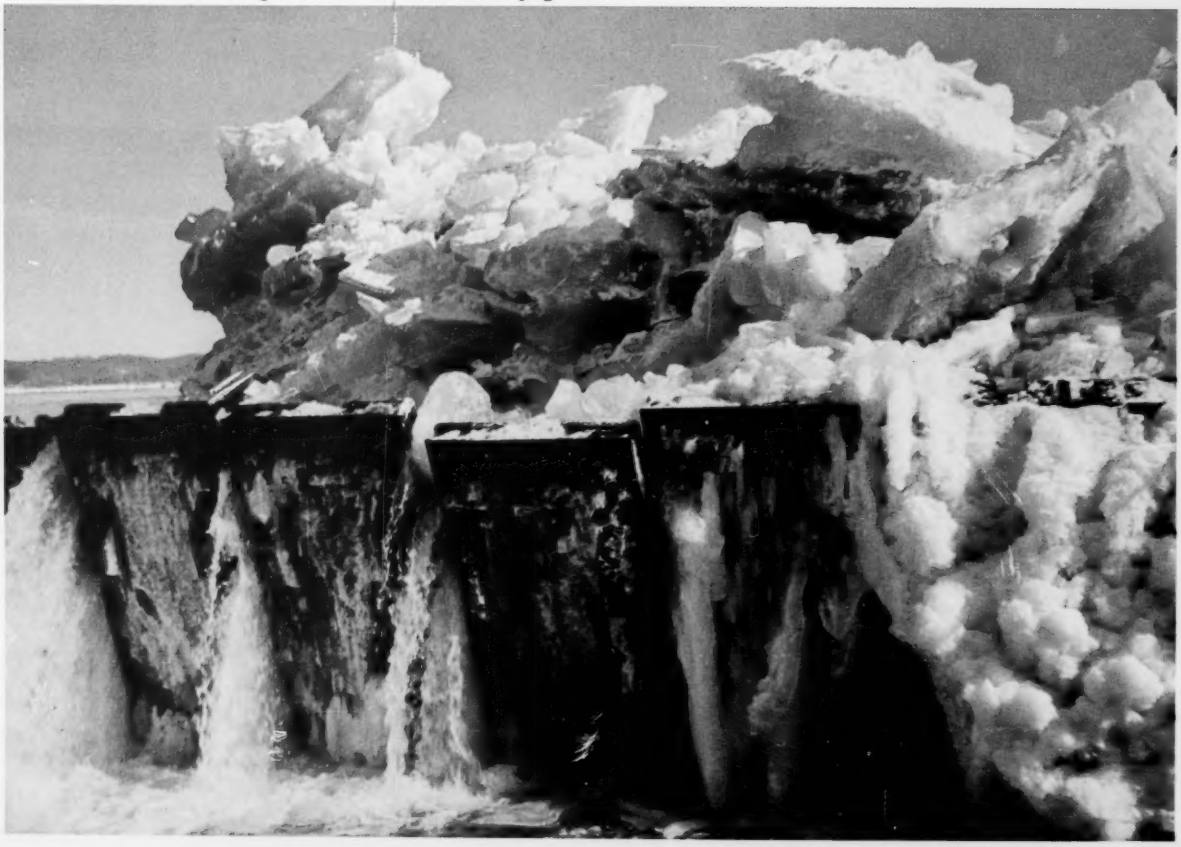
This towering mass of ice threatened a navigation dam on the Ohio River during the winter of '77. See page 30.